



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

B 428297

METROPOLITAN WATER AND SEWERAGE BOARD

SEVENTEENTH ANNUAL REPORT

DECEMBER 31, 1917



Class _____

Book _____

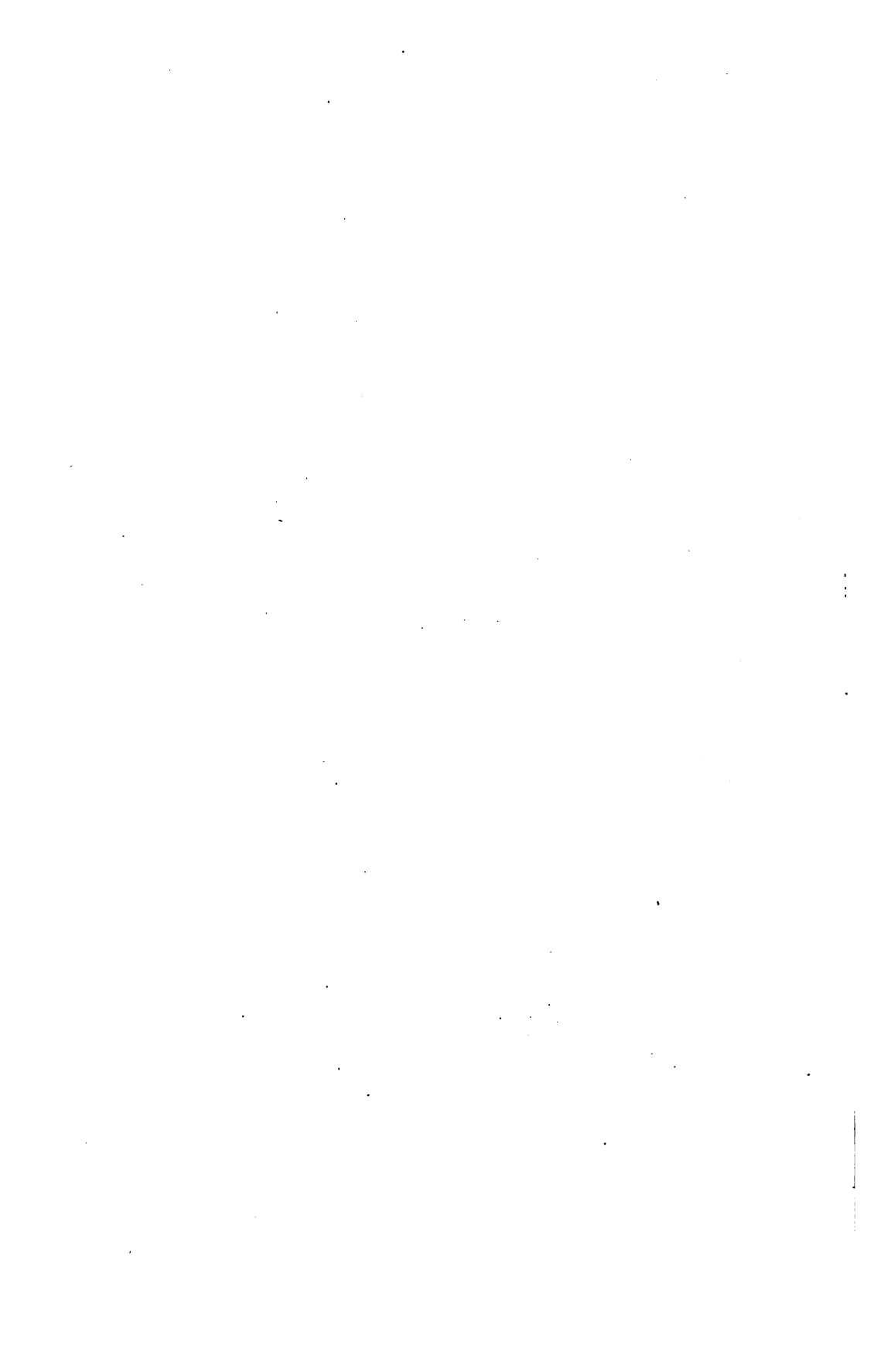


TD

25

.B7

A3



SEVENTEENTH ANNUAL REPORT

OF THE

Massachusetts

METROPOLITAN WATER AND SEWERAGE BOARD.

12-33457

FOR THE YEAR 1917.



BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
32 DERNE STREET.
1918.

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

D. of D.
AUG 15 1918

Dup. 18
D. of D.

CONTENTS.

	PAGE
I. Organisation and Administration,	1
Board, Officers and Employees,	1
II. Metropolitan Water District,	3
III. Metropolitan Water Works — Construction,	3
IV. Water Works — Maintenance,	5
(1) Storage Reservoirs,	5
(2) Aqueducts,	5
(3) Pumping Stations,	6
(4) Protection of the Water Supply,	7
(5) Clinton Sewerage Works,	8
(6) Forestry,	9
(7) Wachusett Power Plant,	10
(8) Sudbury Power Plant,	10
(9) Rainfall and Water Supply,	10
(10) Water Consumption,	11
V. Water Works — Financial Statement,	11
(1) Water Loans — Receipts and Payments,	12
(2) Total Water Debt, December 31, 1917,	12
(3) Metropolitan Water Loan and Sinking Fund, December 31, 1917,	13
(4) Water Assessment, 1917,	13
(5) Supplying Water to Cities and Towns outside of District and to Water Companies,	14
(6) Expenditures for the Different Works,	15
(7) Detailed Financial Statement under Metropolitan Water Act,	17
(a) Expenditures and Disbursements,	17
(b) Receipts,	22
(c) Assets,	23
(d) Liabilities,	23
VI. Metropolitan Sewerage Works,	24
(1) North Metropolitan Sewerage System — Construction,	24
(2) North Metropolitan Sewerage System — Maintenance,	26
Sewers and Pumping Stations,	26
(3) South Metropolitan Sewerage System — Construction,	27
(4) South Metropolitan Sewerage System — Maintenance,	29
Sewers and Pumping Stations,	29
VII. Sewerage Works — Financial Statement,	30
(1) Metropolitan Sewerage Loans, Receipts and Payments,	30
North Metropolitan System,	30
South Metropolitan System,	31
(2) Total Sewerage Debt, December 31, 1917,	32
North Metropolitan System,	32
South Metropolitan System,	32
(3) North and South Metropolitan Loan and Sinking Funds, December 31, 1917,	33
(4) Annual Appropriations, Receipts and Expenditures,	34
(5) Sewer Assessments, 1917,	34
(6) Expenditures for the Different Works,	36
(7) Detailed Financial Statement,	37
(a) Expenditures and Disbursements,	37
(b) Receipts,	42
(c) Assets,	43
(d) Liabilities,	43
VIII. Recommendations for Legislation,	43

	PAGE
Report of Chief Engineer of Water Works,	47
Organisation,	47
Construction,	48
Deferred Projects,	48
Wachusett-Sudbury Power Transmission Line,	49
Additional Northern High-service Pipe Line and Pumping Machinery,	52
Meters and Connections,	53
Maintenance,	55
Rainfall and Yield of Watersheds,	55
Storage Reservoirs,	56
Wachusett Reservoir,	57
Sudbury Reservoir,	59
Framingham Reservoir No. 3,	60
Framingham Reservoirs Nos. 1 and 2, Ashland, Hopkinton and Whitehall Reservoirs,	60
Farm Pond,	62
Lake Cochituate,	62
Aqueducts,	63
Wachusett Aqueduct,	63
Sudbury Aqueduct,	64
Weston Aqueduct,	65
Cochituate Aqueduct,	66
Sanitary Inspection of Watersheds,	67
Wachusett Watershed,	67
Sudbury Watershed,	70
Cochituate Watershed,	70
Protection of the Water Supply,	70
Filtration and Chlorination,	70
Improvement of Swamps and Brooks,	72
Clinton Sewage Disposal Works,	73
Forestry,	75
Wachusett Department,	75
Sudbury Department,	78
Pipe Lines and Reservoirs Department,	79
Hydro-electric Service,	80
Wachusett Power Station,	80
Sudbury Power Station,	82
Distribution Pumping Service,	83
Chestnut Hill Pumping Stations,	87
Spot Pond Pumping Station,	89
Arlington Pumping Station,	90
Hyde Park Pumping Station,	91
Distribution Reservoirs,	92
Weston Reservoir,	93
Chestnut Hill, Fisher Hill and Waban Hill Reservoirs,	93
Spot Pond, Fells and Bear Hill Reservoirs,	94
Bellevue and Forbes Hill Reservoirs,	94
Arlington and Mystic Reservoirs,	95
Mystic Lake, Conduit and Pumping Station,	95
Grounds at Arlington and Hyde Park Pumping Stations,	95
Protection of Water Supply,	96
Distribution Pipe Lines,	96
Pipe Bridges,	96
Pipe Yards,	97
Meters, Regulating Valves and Recording Pressure Gages,	97
Breaks and Leaks,	98
Emergency Pipe Line Service,	100
Consumption of Water,	100
Installation of Meters on Service Pipes,	102
Water supplied outside of Metropolitan Water District,	104
Protection of Water Works Structures,	104
Quality of the Water,	104
Engineering,	105

CONTENTS.

v

	PAGE
Report of Chief Engineer of Sewerage Works,	106
Organisation,	106
Metropolitan Sewerage Districts,	107
Areas and Populations,	107
Metropolitan Sewers,	108
Sewers purchased and constructed and their Connections,	108
Construction,	111
North Metropolitan Sewerage System,	111
Section 1, Deer Island Outfall Extension,	111
Extension to Reading,	112
South Metropolitan Sewerage System,	112
Wellesley Extension,	112
Section 98, Wellesley Extension,	112
Section 99, Wellesley Extension,	113
Section 100, Wellesley Extension,	113
Section 101, Wellesley Extension,	113
Section 102, Wellesley Extension,	113
Maintenance,	114
Scope of Work and Force employed,	114
Deer Island Pumping Station,	115
East Boston Pumping Station,	115
Charlestown Pumping Station,	115
Ward Street Pumping Station,	115
Seattle Street Conduit Crossing,	116
Nut Island,	116
Government Use of Old 24-inch Quincy Force Main,	116
Study of Sewerage in Mill Brook Valley in Arlington,	116
Gasolene in Public Sewers,	120
Drainage from Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham,	122
Data relating to Areas and Populations contributing Sewage to Metropolitan Sewerage System,	124
North Metropolitan System,	124
South Metropolitan System,	125
Whole Metropolitan System,	126
Pumping Stations,	127
Capacity and Results,	127
North Metropolitan System,	127
Deer Island Pumping Station,	127
East Boston Pumping Station,	129
Charlestown Pumping Station,	130
Alewife Brook Pumping Station,	132
South Metropolitan System,	133
Ward Street Pumping Station,	133
Quincy Pumping Station,	135
Nut Island Screen-house,	136
Quincy Sewage Lifting Station,	136
Metropolitan Sewerage Outfalls,	138
Material intercepted at the Screens,	140

Appendix No. 1. — Contracts relating to the Metropolitan Water Works made and pending during the Year 1917,	142
Appendix No. 2. — Tables relating to the Maintenance of the Metropolitan Water Works,	149
Table No. 1. — Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works in 1917,	149
Table No. 2. — Rainfall in Inches at Jefferson, Mass., in 1917,	150
Table No. 3. — Rainfall in Inches at Framingham, Mass., in 1917,	151
Table No. 4. — Rainfall in Inches at Chestnut Hill Reservoir in 1917,	152
Table No. 5. — Rainfall in Inches on the Wachusett Watershed, 1897 to 1917,	154
Table No. 6. — Rainfall in Inches on the Sudbury Watershed, 1875 to 1917,	155

Appendix No. 2 — *Continued.*

	PAGE
Table No. 7. — Yield of the Wachusett Watershed in Gallons per Day per Square Mile from 1897 to 1917,	157
Table No. 8. — Yield of the Sudbury Watershed in Gallons per Day per Square Mile from 1875 to 1917,	159
Table No. 9. — Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1917,	163
Table No. 10. — Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1917,	164
Table No. 11. — Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1917,	165
Table No. 12. — Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month,	166
Table No. 13. — Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District,	167
Table No. 14. — Average Daily Quantity of Water flowing through Aqueducts in 1917 by Months,	168
Table No. 15. — Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill Pumping Station No. 1 for the Year 1917,	169
Table No. 16. — Statement of Operation of Engine No. 3 at Chestnut Hill Pumping Station No. 1 for the Year 1917,	170
Table No. 17. — Statement of Operation of Engine No. 4 at Chestnut Hill Pumping Station No. 1 and Summary for the Station for the Year 1917,	171
Table No. 18. — Statement of Operation of Engines Nos. 5, 6 and 7 at Chestnut Hill Pumping Station No. 2 for the Year 1917,	172
Table No. 19. — Statement of Operation of Engine No. 12 at Chestnut Hill Pumping Station No. 2 for the Year 1917,	173
Table No. 20. — Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1917,	174
Table No. 21. — Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1917,	175
Table No. 22. — Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1917,	176
Table No. 23. — Statement of Operation of Engine No. 11 at Arlington Pumping Station for the Year 1917,	177
Table No. 24. — Statement of Operation of Engines Nos. 13 and 14 at Hyde Park Pumping Station for the Year 1917,	178
Table No. 25. — (Meter Basis) Average Daily Consumption of Water by Districts in Cities and Towns supplied by the Metropolitan Water Works in 1917,	179
Table No. 26. — (Meter Basis) Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works in 1917,	180
Table No. 27. — (Pump Basis) Consumption of Water in the Metropolitan Water District, as constituted in the Year 1917, and a Small Section of the Town of Saugus, from 1893 to 1917,	183
Table No. 28. — Chemical Examinations of Water from the Wachusett Reservoir, Clinton,	185
Table No. 29. — Chemical Examinations of Water from the Sudbury Reservoir,	186
Table No. 30. — Chemical Examinations of Water from Spot Pond, Stoneham,	187
Table No. 31. — Chemical Examinations of Water from Lake Cochituate,	188
Table No. 32. — Chemical Examinations of Water from a Tap at the State House, Boston,	189
Table No. 33. — Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1917,	190
Table No. 34. — Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1917,	191
Table No. 35. — Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1917, inclusive,	192
Table No. 36. — Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1917, inclusive,	194
Table No. 37. — Colors of Water from Various Parts of the Metropolitan Water Works in 1917,	195
Table No. 38. — Temperatures of Water from Various Parts of the Metropolitan Water Works in 1917,	196
Table No. 39. — Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1917,	197

CONTENTS.

vii

Appendix No. 2 — Concluded.	PAGE
Table No. 40. — Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1917,	198
Table No. 41. — Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1917,	199
Table No. 42. — Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1917,	200
Table No. 43. — Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works,	201
Table No. 44. — Average Elevations of the Hydraulic Grade Line in Feet above Boston City Base for each Month at Stations on the Metropolitan Water Works during 1917,	202
Appendix No. 3. — Water Works Statistics for the Year 1917,	204
Appendix No. 4. — Contracts relating to the Metropolitan Sewerage Works, made and pending during the Year 1917,	206
Appendix No. 5. — Financial Statement presented to the General Court on Jan. 16, 1918,	211
Appendix No. 6. — Legislation of the Year 1917 affecting the Metropolitan Water and Sewerage Board,	216

ME

To H

T
the
alre
of i
the
anc
190
yes

ar
A
cl
N
b

a
r
t

|
:
:
:
:

METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1917, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, presents a detailed statement of its doings for the calendar year ending on December 31, 1917, being its

SEVENTEENTH ANNUAL REPORT.

I. ORGANIZATION AND ADMINISTRATION.

BOARD, OFFICERS AND EMPLOYEES.

The term of office of Henry P. Walcott expired on March 20, and he was reappointed for the term of three years next succeeding. At the end of the year the Board consisted of Henry P. Walcott, chairman, Edward A. McLaughlin and Thomas E. Dwyer. William N. Davenport has continued as secretary. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, a first clerk, one general clerk, two stenographers and clerks, a telephone operator, and a janitor with two assistants, both of whom act as watchmen.

Such general conveyancing work and investigation of real estate titles in the different counties as have been called for during the year have been performed by George D. Bigelow.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require their consideration.

William E. Foss is Chief Engineer of Water Works and John L. Howard Assistant to the Chief Engineer. The following are superintendents of departments under the direction of the Chief Engineer: Eliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Co-chituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct, and of all distributing reservoirs and pipe lines within the Metropolitan Water District; and Arthur E. O'Neil, Superintendent of the several Water Works pumping stations.

The average engineering force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 1 assistant to Chief Engineer, 4 department superintendents, 1 division engineer, 8 assistant engineers and 26 others in various engineering capacities, and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 41.

A maintenance force in addition to those engaged in engineering capacities, as above mentioned, numbering upon the average during the year 284, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines and upon minor construction work. At the end of the year this force numbered 282.

Frederick D. Smith is Chief Engineer of Sewerage Works. He has been assisted by Henry T. Stiff, Division Engineer in charge of the office and drafting, by 4 assistant engineers and by 17 others employed in different engineering capacities, and by 2 stenographers and clerks.

The maximum engineering force employed at any one time during the year on the construction and maintenance of the Sewerage Works was 26.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, on the average has been 160.

The whole regular force of the Sewerage Department at the end of the year numbered 182, of whom the Chief Engineer and 21 assistants and draftsmen were engaged in general upon the works, and of the remainder, 96 were employed upon the North System and 64 upon the South System.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending September 22, when the number amounted to 180.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy, Revere and Somerville, and the towns of Arlington, Belmont, Lexington, Milton, Nahant, Stoneham, Swampscott, Watertown and Winthrop, — in all 10 cities and 9 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the State Census taken for April 1, 1915, was 1,201,300. The population of the District on July 1, 1917, the date upon which calculations for the Water Works are based, was estimated as 1,260,480.

III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been \$42,983,832.39.

The total amount expended during the calendar year on account of the construction and acquisition of works has been \$60,240.76. The details of this expenditure are as follows: on account of the construction of a steel tank or reservoir on Bellevue Hill with connecting pipe lines the sum of \$354.13; for work on account of the power plant at Sudbury Dam and the construction of the Wachusett-Sudbury transmission line, \$23,191.15; for relocation of meters and connections, \$19,071.49; for installing a new pumping engine at the Arlington pumping station, \$7,434.14; for stock on hand, \$9,334.93; and for other minor works, engineering and administration expenses, the sum of \$854.92.

The construction of an electric transmission line from the Sudbury Dam power station to the similar station at the Wachusett Dam is so far completed that the production of power at these two stations can be used in the most advantageous manner during the coming season. The line, with very few exceptions, has been laid out on lands of the Commonwealth which are under the control of the Board. The Metropolitan District will then have secured and

will continue to receive for all time a very substantial income, which will not only do something to relieve the burden of debt resting upon the District but will also more than restore to the district, in which a serious destruction of existing water powers was made, an amount of power far in excess of anything which that district had ever enjoyed.

During the year the Board acquired the fee of 2.36 acres of land in Southborough for the construction of the Wachusett-Sudbury transmission line.

By chapter 814 of the Acts of 1913 authority was given the Board to improve Beaver Dam Brook in the towns of Ashland, Framingham, Sherborn and Natick. The improvement was offered for contract on July 24, 1916, but the lowest bid was \$20,000 in excess of the amount available for the work and the Board was accordingly unable to carry out the provisions of this legislation. The Board has, however, by the employment of its own working force, effected an improvement in the condition of the bed and banks of this stream sufficient to obviate, for the present at least, any anxiety as to its influence upon the health of the surrounding territory or an increasing menace to the waters of Lake Cochituate.

In several directions there will be needed very large expenditures for construction in the immediate future. The Board has hesitated to bring them forward during these troubled times, but a much longer delay to do so would be inexcusable. Additional pipe lines are needed for the better and safer supply of the District. These will require large amounts of money and the work will, of necessity, involve much time in its execution. Whenever the growth of the population makes imperative the use of all the sources of water now available some system of filtration must be established in order to maintain the satisfactory quality of the water now supplied. Consideration has already been given to this subject and preliminary plans have been suggested.

Some encouragement to large expenditures may be found in the fact that in this District water for domestic uses is the only article indispensable to man's life which has not been increased in price by the present disturbed conditions in the world.

In the minds of some not familiar with systems of water works there seems to exist an idea that when great works have been constructed the labors of oversight have ended. As a matter of fact

they have then become most urgent. The State Board of Health in its report of 1895 upon a Metropolitan Water System very carefully stated the many problems which the coming water board would have to meet, and experience has shown that the statement was not overdrawn.

It may be claimed with entire justice that the ability adequately to maintain a complicated system of water supply requires qualifications not inferior to those of the men employed in the original construction however they may differ in character.

IV. WATER WORKS — MAINTENANCE.

The maintenance and operation of the Metropolitan Water Works during the past calendar year have required the expenditure of \$535,195.76.

(1) STORAGE RESERVOIRS.

The water in the Wachusett Reservoir reached its highest elevation, 395.55, on June 17.

The Sudbury Reservoir was at elevation 258.49 at the beginning of the year and was kept at this elevation until flash-boards were put in place April 9. From this time the water was maintained between elevations 259 and 260 until early in November when it was drawn down to elevation 257 to facilitate the erection of the poles for the Wachusett-Sudbury transmission line. During the winter the water in Framingham Reservoir No. 3 was kept below the crest of the overflow and during warm weather the water was kept above the crest between elevations 185 and 186. Water was drawn from Lake Cochituate for the water supply in August and September.

It has not been necessary to draw water for the supply of the Metropolitan District from Framingham Reservoir No. 1, Framingham Reservoir No. 2, Ashland, Hopkinton and Whitehall reservoirs.

(2) AQUEDUCTS.

The Wachusett Aqueduct was in service for the passage of water from the Wachusett Reservoir to the Sudbury Reservoir during the whole or portions of 302 days. The quantity of water flowing through the aqueduct was equal to an average of 90,120,000 gallons per day for the entire year. Of the total quantity of water ad-

mitted to the aqueduct 99.1 per cent. was used before its admission for the development of electric energy.

For distribution to the cities and towns of the Metropolitan District water was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir every day in the year, the daily average for the whole year being 55,553,000 gallons.

The Weston Aqueduct was in use on 304 days, the quantity of water delivered through the aqueduct being equivalent to a daily average of 52,079,000 gallons.

Water was discharged through the Cochituate Aqueduct on 29 days during the year, the total quantity of water discharged being 125,400,000 gallons.

(3) PUMPING STATIONS.

The total amount of water pumped at all the pumping stations was 23,608,020,000 gallons, which is 1,568,750,000 gallons more than in the previous year.

The following are the several pumping stations: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill high-service station,	4	66,000,000	138
Chestnut Hill low-service station,	3	105,000,000	60
Chestnut Hill low-service station,	1	40,000,000	130
Spot Pond station,	2	30,000,000	125
Arlington station,	2	3,000,000	290
Hyde Park station,	2	6,000,000	140

The amount expended for the operation of the stations was \$135,215.75, which is \$36,942.53 more than for the year 1916.

The total amount of coal purchased during the year was 9,236.93 gross tons, of which 5,814.87 tons were bituminous and 3,422.06 tons anthracite. All of the anthracite coal was screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from \$5.55 to \$8.81, and the average cost of anthracite coal varied from \$4.06 to \$5.39.

(4) PROTECTION OF THE WATER SUPPLY.

The Marlborough Brook filter-beds, on which is filtered the water received from brooks passing through the thickly settled portions of Marlborough, have been adequate for the filtration of all the water received.

The Pegan Brook pumping station, at which is pumped upon the filter-beds the surface drainage of about one square mile in the thickly settled portion of Natick, was in successful operation on 234 days in the year.

The filter-beds which receive for filtration the water flowing through the thickly settled portion of the town of Sterling, as well as the smaller filter-beds which receive the drainage from a few houses near Sterling Junction, the Worcester County Training School at West Boylston and from the swimming pool at Southborough, have been in successful operation and required only the usual attention during the year.

Studies for the disposal of manufacturing wastes, as well as for the disposal of house drainage from the various towns within the drainage area of the Metropolitan Water System, have been in progress during the year.

Constant inspection of the watersheds has been maintained by the Sanitary Inspector and his assistants and members of the maintenance force.

Chemical examinations of the waters used were made by the State Department of Health, and in addition, microscopical and bacterial examinations were made by the Board. These examinations enable the Board to take measures to remedy any difficulties which are found to exist.

The quality of the water brought to the Metropolitan District continues to be satisfactory both in taste and in appearance. This condition results in a large measure from the fact that it is still possible to reject some of the sources which were in use before the extension of the water works to the South Branch of the Nashua River at Clinton. The water derived from the Wachusett watershed has been superior to that coming from the Sudbury and Cochituate sources. The first-named supply, so far as possible, has been that conveyed to the District; the others have been wasted to a greater or less extent as occasion has permitted.

The time, however, is approaching when all the sources will be required for the supply of the District. When that day arrives it will be necessary, without doubt, to filter these inferior waters in order to bring them to the standard of excellence to which the District has become accustomed since the establishment of the Metropolitan Water Supply.

During the year the Board acquired the fee of 15.81 acres of land in Boylston for the protection and improvement of the water supply.

(5) CLINTON SEWERAGE WORKS.

The Board has maintained and operated since September 15, 1899, works for the disposal of the sewage of the town of Clinton on lands acquired for the purpose in the town of Lancaster under the authority of chapter 557 of the Acts of the year 1898. By section 3 of this chapter "The metropolitan water board shall maintain and operate the works constructed by it, unless otherwise agreed by said board and the town of Clinton, until the sewage of said town shall have outgrown the normal capacity of the south branch of the Nashua river to properly dispose thereof; and then said board shall transfer to said town all the works, lands, water rights, rights of way, easements and other property constructed and acquired under the provisions hereof, upon such terms as may be agreed upon by said board and said town, and thereafter said works, lands, water rights, rights of way, easements and other property shall be owned, maintained and operated by the town of Clinton under the supervision and control of the state board of health, and said town shall pay to the Commonwealth for the property so transferred such sum or sums, if any, as may be agreed by said town and said board to be just and proper."

In the opinion of the Board the time is near at hand, if it has not already been reached, when this provision of the statute should become operative. Repeated examinations of the material now treated upon the South Lancaster filter-beds both as to quantity and quality would seem to show that the amount of sewage here treated could not be turned into the South Branch of the Nashua River without producing conditions of serious importance to the inhabitants of the towns on the stream below this point.

(6) FORESTRY.

An area of about 74 acres back of the westerly portion of the North Dike at the Wachusett Reservoir was cleared of a growth of scrub oak and planted with four-year-old white pine seedlings from the North Dike nursery. An area of $3\frac{1}{2}$ acres located near the terminal chamber of the Wachusett Aqueduct was cleared and planted with four-year-old white pine seedlings from the North Dike nursery.

Along the open channel of the Wachusett Aqueduct in Southborough and the marginal lands of the Wachusett Reservoir in Clinton, Boylston, and West Boylston $103\frac{1}{2}$ acres of water works land were planted with four-year-old white pine seedlings from the North Dike nursery and five-year-old white spruce seedlings from the Oakdale nursery. In this work 98,100 white pine and 1,300 white spruce seedlings were used. In the fall 8,550 five-year-old white pine seedlings were planted to fill in where trees from previous plantings had died, and about 700 white pine trees 18 to 24 inches in height were set out on the site of three buildings which were removed from water works land between High Street and the Clinton sewerage filter-beds in Lancaster.

There are now in the Oakdale nursery 202,870 seedlings from one to six years old and in the North Dike nursery 44,000 three and five-year-old seedlings, which are ready for future planting.

Since the beginning of forestal work on Wachusett Reservoir marginal lands, 1,497 acres have been planted.

About 28 acres of Sudbury Reservoir marginal lands were cleared of small trees and brush and 49,300 three-year-old white pine seedlings, 43,700 three-year-old Scotch pines, 44,050 three-year-old red pines and 43,500 four-year-old white spruces were planted from the nursery. Fifteen hundred three-year-old white pines were set out west of Edgell Street, Nobscot and 1,500 were set out on the gravel slope between the aqueduct and the old Connecticut Path in Wayland.

The ravages of the gypsy and brown-tail moths and of the elm-leaf beetle and the pine tree weevil have continued during the year, requiring a large amount of work and considerable expense to protect the trees on lands controlled by the Board. The egg clusters of the gypsy moth have been painted with creosote and nests of the

brown-tail moth destroyed by burning, and extensive spraying has been required for the preservation of trees infested by moths and elm-leaf beetles. It has been noticed that the brown-tail moth has entirely disappeared from water works lands in the Wachusett Department. The pine tree blister has not yet been found on the Wachusett Reservoir lands.

(7) WACHUSETT POWER PLANT.

The hydro-electric power station at the Wachusett Dam was operated on 299 days during the year. The energy not used in connection with the operation of the Metropolitan Water Works was sold to the New England Power Company under an agreement made September 30, 1916, which provides that until the completion of the Wachusett-Sudbury transmission line the Company will take as much energy from the Wachusett power station as it can reasonably and properly use without wasting water at its own plants. The operation of the plant continues to be successful, the gross earnings for the year being \$37,269.46. The cost of operating the plant has been \$16,948.98, the net earnings \$20,320.48, and the net earnings per thousand kilowatt hours generated, \$2.89.

(8) SUDBURY POWER PLANT.

The hydro-electric power station at the Sudbury Dam was operated on 304 days during the year. The entire output, with the exception of a small amount of energy used for lighting the station and operating the electrically driven accessories, has been sold to the Edison Electric Illuminating Company of Boston under a contract dated December 21, 1914. The gross earnings for the year were \$30,962.47, the cost of operating the plant \$18,581.26 and the net earnings \$12,111.21. The net earnings per thousand kilowatt hours generated were \$2.466.

(9) RAINFALL AND WATER SUPPLY.

The rainfall is still below the average, and somewhat less than in the preceding year. On the Wachusett watershed the rainfall was 37.26 inches and on the Sudbury watershed 41.51 inches, while the averages for the periods covered by the records have been, respectively, 44.91 inches and 44.60 inches.

The Wachusett watershed yielded a daily average of 834,000

gallons per square mile, which is 78.5 per cent. of the average for the past twenty-one years, and the Sudbury watershed yielded a daily average of 750,000 gallons per square mile, which is 76.5 per cent. of the average for the past forty-three years. The yield from the Cochituate watershed was 786,000 gallons per day per square mile, which is 85.5 per cent. of the average for the past fifty-five years.

(10) WATER CONSUMPTION.

During the year the quantity of water supplied to the Metropolitan Water District amounted to a daily average of 110,032,300 gallons as measured by Metropolitan Water Works meters, which was equivalent to 90 gallons for each person in the District. This quantity was 3,699,500 gallons more than the average daily consumption of the preceding year.

Acting under the authority conferred by several statutes and arrangements which have been made, water has been supplied to a limited extent outside of the Metropolitan Water District. There has been drawn from the open channel of the Wachusett Aqueduct for the use of the Westborough State Hospital a daily average quantity of 157,000 gallons. The town of Framingham has, under the provisions of the statute, drawn indirectly from Farm Pond a daily average quantity of 569,300 gallons and directly from the Sudbury Aqueduct 499,452 gallons. A portion of the town of Saugus has been supplied through the city of Revere with an average of 12,900 gallons daily. The United States Government, for use on Peddock's Island, has been supplied with a daily average of 87,300 gallons. The sums charged for the water thus supplied have amounted to \$8,598.58.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1916, and ending with November 30, 1917, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

As required by said chapter a detailed statement of its doings for the calendar year 1917, in relation to the Metropolitan Water Works, is herewith presented.

CONSTRUCTION.

(1) WATER LOANS — RECEIPTS AND PAYMENTS.

Total loans authorized to January 1, 1918,	\$42,798,000 00
Receipts from the sales of property applicable to the construction and acquisition of works:—	
For the period prior to January 1, 1917,	\$252,478 79
For the year ending December 31, 1917,	1,366 66
	<hr/>
	253,845 45
Receipt from the town of Swampscott for admission to District (St. 1909, c. 320),	90,000 00
	<hr/>
Total amount authorized to January 1, 1918,	\$43,141,845 45
Amounts approved by Board for payments out of Water Loan Fund:—	
Payments prior to January 1, 1917,	\$42,923,591 63
Approved for year ending December 31, 1917,	60,240 76
	<hr/>
	42,983,832 39
Amount authorized but not expended January 1, 1918,	\$158,013 06

(2) TOTAL WATER DEBT, DECEMBER 31, 1917.

Water Loan Outstanding, Sinking Fund and Debt.

Bonds issued by the Treasurer of the Commonwealth:—	
Sinking fund bonds (3 and 3½ per cent.),	\$41,398,000 00
Serial bonds (3½ and 4 per cent.),	1,354,000 00
	<hr/>
Total bond issue to December 31, 1917,	\$42,752,000 00
Serial bonds paid prior to January 1, 1917,	\$72,000 00
Serial bonds paid in 1917,	32,000 00
	<hr/>
	104,000 00
Total bond issue outstanding December 31, 1917,	\$42,648,000 00
Gross Water Debt,	\$42,648,000 00
Sinking fund December 31, 1917,	14,036,278 88
	<hr/>
Net Water Debt December 31, 1917,	\$28,611,721 12
A decrease for the year of \$650,079.52.	

(3) METROPOLITAN WATER LOAN AND SINKING FUND,
DECEMBER 31, 1917.

YEAR.	Authorized Loans.	Bonds issued (Sinking Fund).	Bonds issued (Serial Bonds).	Sinking Fund.
1895,	\$27,000,000	\$5,000,000	-	\$226,286 05
1896,	-	2,000,000	-	699,860 70
1897,	-	6,000,000	-	954,469 00
1898,	-	4,000,000	-	1,416,374 29
1899,	-	3,000,000	-	1,349,332 97
1900,	-	1,000,000	-	1,573,619 72
1901,	13,000,000	10,000,000	-	1,662,426 95
1902,	-	3,500,000	-	2,256,803 81
1903,	-	1,500,000	-	2,877,835 59
1904,	-	2,500,000	-	3,519,602 92
1905,	-	650,000	-	4,207,045 69
1906,	500,000	1,350,000	-	4,897,822 62
1907,	-	-	-	5,643,575 69
1908,	398,000	-	-	6,419,283 28
1909,	900,000	398,000	-	7,226,262 31
1910,	80,000	500,000	-	8,089,902 91
1911,	212,000	-	\$200,000	8,953,437 44
1912,	600,000	-	190,000	9,829,356 80
1913,	108,000	-	-	10,767,701 68
1914,	-	-	258,000	11,533,453 45
1915,	-	-	490,000	12,491,245 25
1916,	-	-	66,000	13,268,199 36
1917,	-	-	150,000	14,036,278 88
	\$42,798,000	\$41,388,000	\$1,354,000	-

(4) WATER ASSESSMENT, 1917.

The following water assessment was made by the Treasurer of the Commonwealth upon the various municipalities: —

Sinking fund requirements,	\$260,500 34
Serial bonds,	\$37,000 00
Less premium,	1,260 00
	<hr/> 35,740 00
Interest,	1,464,158 15
Maintenance: —	
Appropriated by Legislature,	\$572,900 00
Less balance on hand,	24,985 75
	<hr/> 547,914 25
Total water assessment for 1917,	\$2,308,312 74

In accordance with chapter 488, Acts of 1895, as amended in 1901, 1904 and 1906, the proportion to be paid by each city and town is based one-third in proportion to their respective valuations and the remaining two-thirds in proportion to their respective water consumption for the preceding year, except that but one-fifth of the total valuation and no consumption has been taken for the city of Newton, as it has not been supplied with water from the Metropolitan Works.

The division of the assessment for 1917 was as follows: —

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$20,544 00	Nahant,	\$5,539 95
Belmont,	11,132 99	Newton,	6,523 29
Boston,	1,752,004 76	Quincy,	59,042 03
Chelsea,	55,819 61	Revere,	31,688 52
Everett,	54,125 31	Somerville,	118,425 67
Lexington,	9,357 91	Stoneham,	8,614 63
Malden,	51,636 95	Swampscott,	12,460 26
Medford,	33,666 75	Watertown,	24,045 68
Melrose,	18,335 83	Winthrop,	16,564 45
Milton,	18,284 15		\$2,308,312 74

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF
DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1917 under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

City of Revere (on account of water furnished to a portion of the town of Saugus for 1916),	\$400 00
United States Government (for Peddock's Island),	2,115 79
Westborough State Hospital,	1,455 51
	<hr/>
	\$3,971 30

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District; but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1917.
Administration applicable to all parts of the construction and acquisition of the works,	\$658 78
Wachusett Department, real estate,	3 00
Power Plant at Sudbury Dam,	4,971 46
Wachusett-Sudbury Power Transmission Line,	18,219 69
Distribution system: —	
Low service: —	
Pipe lines and connections,	\$179 14
Northern extra high service: —	
New pumping engine at Arlington pumping station,	7,434 14
Southern extra high service: —	
Section 44 (12-inch connection in West Roxbury),	9 38
Bellevue Reservoir on Bellevue Hill in Boston,	344 75
Weston Aqueduct supply mains,	14 00
Meters and connections,	19,071 49
	27,052 90
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: —	
Amount received,	\$19,836 13
Transferred from storage yards to the various sections of the work and included in costs of special works,	10,501 20
	9,334 93
	60,240 76
Amount charged from beginning of work to January 1, 1917,	42,923,591 63
Total for construction and acquisition of works to January 1, 1918,	\$42,983,832 39

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1917.	
Administration,		\$17,876 18
General supervision,		37,047 60
Taxes and other expenses,		42,634 57
Wachusett Department:—		
Superintendence,	\$8,018 25	
Reservoir,	7,761 31	
Forestry,	13,693 31	
Protection of supply,	11,638 93	
Buildings and grounds,	3,048 24	
Wachusett Dam,	7,174 09	
Wachusett Aqueduct,	12,321 02	
Clinton sewerage system:—		
Pumping station,	1,526 16	
Sewers, screens and filter-beds,	5,336 54	
Sanitary inspection,	1,171 68	
Swamp drainage,	3,859 34	
Power plant,	6,643 98	
Payments under Industrial Accident Law and special benefit appropriations,	80 78	82,273 63
Sudbury Department:—		
Superintendence, Framingham office,	\$11,435 58	
Ashland Reservoir,	2,599 77	
Hopkinton Reservoir,	2,039 67	
Whitehall Reservoir,	1,007 43	
Framingham Reservoirs Nos. 1, 2 and 3,	12,523 08	
Sudbury Reservoir,	8,005 12	
Lake Cochituate,	9,342 17	
Marlborough Brook filters,	2,906 95	
Pegan filters,	4,515 34	
Sudbury and Cochituate watersheds,	1,723 88	
Sanitary inspection,	3,730 68	
Cochituate Aqueduct,	3,260 62	
Sudbury Aqueduct,	11,823 79	
Weston Aqueduct,	9,970 78	
Forestry,	7,596 44	
Power plant,	9,877 26	
Improvement and protection of water supplies,	3,372 50	
Payments under Industrial Accident Law and special benefit appropriations,	510 95	106,242 01
Distribution Department:—		
Superintendence,	\$6,349 16	
Pumping service:—		
Superintendence,	5,098 28	
Payments under Industrial Accident Law and special benefit appropriations,	5 00	
Arlington pumping station, pumping service,	13,418 67	
Chestnut Hill low-service pumping station, pumping service,	58,708 65	
Chestnut Hill high-service pumping station, pumping service,	26,578 13	
Spot Pond pumping station, pumping service,	22,801 02	
Hyde Park pumping station, pumping service,	8,606 00	
Amounts carried forward,	\$141,564 91	\$286,073 99

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1917.	
<i>Amounts brought forward,</i>	\$141,564 91	\$286,073 99
Bear Hill Reservoir,	265 51	
Chestnut Hill Reservoir and grounds,	12,134 26	
Fells Reservoir,	991 90	
Forbes Hill Reservoir,	2,074 32	
Mystic Lake, conduit and pumping station,	3,123 61	
Mystic Reservoir,	1,273 51	
Arlington standpipe,	16 14	
Waban Hill Reservoir,	207 73	
Weston Reservoir,	3,662 06	
Spot Pond,	8,521 86	
Buildings at Spot Pond,	1,231 39	
Pipe lines: —		
Low service,	25,098 22	
Northern high service,	6,399 80	
Northern extra high service,	167 63	
Southern high service,	6,165 33	
Southern extra high service,	173 41	
Supply pipe lines,	501 04	
Buildings at Chestnut Hill Reservoir,	13,791 02	
Chestnut Hill pipe yard,	1,414 23	
Glenwood pipe yard and buildings,	2,604 57	
Stables,	9,949 85	
Venturi meters,	975 08	
Measurement of water,	1,781 98	
Arlington pumping station, buildings and grounds,	650 68	
Hyde Park pumping station, buildings and grounds,	587 80	
Fisher Hill Reservoir,	2,966 66	
Bellevue Reservoir,	251 10	
Payments under Industrial Accident Law and special benefit appropriations,	576 17	
		249,121 77
Total for maintaining and operating works,		\$535,195 76

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1917.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1917, and ending December 31, 1917, was \$60,240.76 and the total amount from the time of the organization of the

Metropolitan Water Board, July 19, 1895, to December 31, 1917, has been \$42,983,832.39.

For maintenance and operation the expenditures for the year were \$535,195.76.

The salaries of the commissioners, and the other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1917.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
Administration.		
Clerks and stenographers,	\$287 55	
Stationery and printing,	205 27	
Postage, express and telegrams,	40 00	
Alterations and repairs of building,	44	
Telephone, lighting, heating, water and care of building,	74 03	
Rent and taxes, main office,	46 49	
Miscellaneous expenses,	5 00	
Engineering.		
Chief engineer,	\$303 03	
Principal assistant engineers,	765 18	
Engineering assistants,	1,387 51	
Consulting engineers,	591 00	
Inspectors,	377 50	
Railroad and street car travel,	212 89	
Stationery and printing,	133 74	
Alterations and repairs of building — main office,	1 34	
Telephone, lighting, heating, water and care of buildings: —		
Main office,	222 12	
Rent and taxes, main office,	139 48	
Miscellaneous expenses,	169 26	
Construction.		
Contracts, Distribution System: —		
Builders Iron Foundry, for furnishing Venturi meters and registers, Contract 375,	\$1,423 00	
Coffin Valve Co., for furnishing 36-inch and 48-inch check valves, Contract 378A,	2,350 00	
Coffin Valve Co., for furnishing screw-lift water valves, Contract 377,	6,965 00	
Fred A. Houdlette & Son, Inc., for furnishing cast-iron frames and covers, Contract 381,	913 36	
Ludlow Valve Mfg. Co., for furnishing check valves, Contract 378,	1,019 55	
Amounts carried forward,	\$12,670 91	\$4,961 83

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1917.	
<i>Amounts brought forward,</i>	\$12,670 91	\$4,961 83
<i>Construction — Con.</i>		
<i>Contracts, Distribution System — Con.</i>		
F. A. Massur & Co., for furnishing and installing a centrifugal pumping unit at the northern extra high-service pumping station at Arlington, Mass., Contract 382,	3,850 00	
New England Structural Co., for furnishing steelwork for valve chambers for 36-inch valves, Contract 380,	961 17	
Daniel Russell Boiler Works, Inc., for furnishing street chambers for Venturi meter registers, Contract 379,	1,650 00	
Standard Cast Iron Pipe & Foundry Co., for furnishing special castings, Contract 374,	4,264 48	
<i>Contracts, Power Plant at Sudbury Dam: —</i>		
Westinghouse Electric & Mfg. Co., for furnishing and installing hydro-electric machinery at Sudbury Dam, Contract 364A,	2,009 19	
S. Morgan Smith Co., for furnishing and installing hydraulic machinery at Sudbury Dam, Contract 364,	1,326 85	
<i>Contract, Wachusett-Sudbury Power Transmission Line: —</i>		
Fred T. Ley & Co., Inc., for constructing an electric power transmission line between the Wachusett Power Station in Clinton and the Sudbury Power Station in Southborough, Mass., Contract 385,	13,294 14	40,026 74
<i>Additional work: —</i>		
Labor,	\$3,867 80	
Freight and express,	660 34	
Jobbing and repairing,	214 30	
Tools, machinery, appliances and hardware supplies,	505 79	
Electrical supplies,	75 88	
Castings, ironwork and metals,	465 17	
Iron pipe and valves,	1,157 86	
Paint and coating,	350 83	
Lumber and field buildings,	317 41	
Drain pipe,	5 85	
Brick, cement and stone,	695 98	
Sand, gravel and filling,	55 25	
Miscellaneous expenses,	38 55	
		13,411 01
<i>Real Estate.</i>		
<i>Legal and expert: —</i>		
Conveyancing supplies,	\$3 00	
Conveyancing expenses,	88 18	
Settlements made by the Board,	1,750 00	
		1,841 18
		60,240 76
Amount charged from beginning of work to January 1, 1917,		42,923,591 63
Total amount of construction expenditures to January 1, 1918,		\$42,983,832 39

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1917.
MAINTENANCE AND OPERATION OF WORKS.	
Administration: —	
Commissioners,	\$7,416 67
Secretary and assistants,	7,439 93
Rent,	703 60
Repairs of building,	25 33
Fuel,	130 60
Lighting,	76 48
Care of building,	591 99
Postage,	156 00
Printing, stationery and office supplies,	1,028 44
Telephones,	122 70
Traveling expenses,	61 26
Miscellaneous expenses,	123 18
	<hr/> \$17,876 18
General supervision: —	
Chief engineer and assistants,	\$28,186 37
Rent,	2,110 83
Repairs of building,	799 61
Fuel,	391 78
Lighting,	230 96
Care of building,	1,776 16
Postage,	193 00
Express and telegrams,	201 30
Printing, stationery and office supplies,	1,284 05
Telephones,	404 96
Traveling expenses,	736 30
Miscellaneous expenses,	732 28
	<hr/> 37,047 60
Pumping service: —	
Superintendence,	\$5,098 28
Labor,	71,117 03
Fuel,	51,464 65
Oil, waste and packing,	1,545 44
Repairs,	4,873 86
Small supplies,	1,111 49
Payments under Industrial Accident Law and special benefit appropriations,	5 00
	<hr/> 135,215 75
Reservoirs, aqueducts, pipe lines, buildings and grounds: —	
Superintendents,	\$7,320 00
Engineering assistants,	12,575 06
Sanitary inspectors,	2,972 58
Labor, pay roll,	197,159 87
Labor, miscellaneous,	2,703 72
Alterations and repairs of pumping stations,	1,405 06
	<hr/>
Amounts carried forward,	<hr/> \$224,136 29 \$190,139 53

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1917.	
<i>Amounts brought forward,</i>	\$224,136 29	\$190,139 53
Reservoirs, aqueducts, pipe lines, buildings and grounds — <i>Con.</i>		
Alterations and repairs of other buildings and structures,	5,249 65	
Automobiles,	12,029 85	
Brick,	237 00	
Brooms, brushes and janitor's supplies,	265 77	
Castings, ironwork and metals,	1,483 12	
Cement and lime,	720 59	
Drafting and photo supplies,	204 55	
Electrical supplies,	1,325 49	
Fertiliser and planting material,	2,209 82	
Freight and express,	395 78	
Fuel,	2,977 48	
Gypsy moth supplies,	2,755 79	
Hardware,	1,469 82	
Hay and grain,	1,425 74	
Horses,	516 00	
Lighting,	307 38	
Lumber,	4,570 80	
Machinery,	1,002 28	
Paints and oils,	1,698 10	
Pipe and fittings,	1,073 00	
Postage,	95 92	
Printing, stationery and office supplies,	650 28	
Rubber and oiled goods,	466 47	
Stable expenses,	776 65	
Sand, gravel and stone,	267 70	
Traveling expenses,	2,381 41	
Telephones,	1,224 77	
Teaming,	3,423 44	
Tools and appliances,	4,195 14	
Vehicles, harnesses and fittings,	256 95	
Miscellaneous expenses,	14,548 63	
Contracts: —		
Crowley & Hickey, Contract 50-M, for constructing the superstructure of garage at Chestnut Hill Reservoir,	6,912 10	
Payments under Industrial Accident Law and special benefit appropriations,	1,167 90	
Payments in lieu of taxes,		302,421 66
		42,634 57
Total expenditures for maintenance and operation,		\$535,195 76

(b) Receipts.

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1917, and ending December 31, 1917, was \$79,753.69, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1917, has been \$1,392,690.87. The general character of these receipts is as follows: —

GENERAL CHARACTER OF RECEIPTS.	For the Year ending December 31, 1917.
Applicable to the loan fund: —	
Land and buildings,	\$100 00
Construction tools, supplies and reimbursements,	1,266 66
	<hr/> \$1,366 66
Applicable to payment of interest, sinking fund requirements and expenses of maintenance and operation: —	
Proceeds from operations of the Board: —	
Rents,	\$1,631 00
Land products,	4,543 72
Electric energy,	64,883 80
Maintenance labor, tools, supplies and reimbursements,	3,254 66
Interest and unclassified receipts,	102 55
	<hr/> 74,415 73
Applicable to the sinking fund: —	
Water supplied to cities and towns, water companies and others,	3,971 30
	<hr/> \$79,753 69
Amount credited from beginning of work to January 1, 1917,	1,312,937 18
	<hr/>
Total receipts to January 1, 1918,	<hr/> \$1,392,690 87

The foregoing receipts have been credited to the various objects or works, as follows: —

SOURCES OF RECEIPTS.	For the Year ending December 31, 1917.
Supplying water outside of Water District,	\$3,971 30
Construction and acquisition of works: —	
Administration,	\$96 48
Wachusett Reservoir,	250 00
Sudbury Reservoir,	48 25
Distribution system,	968 41
Purchase of existing water works,	100 00
	1,463 14
Maintenance and operation of works: —	
Administration,	\$132 32
General supervision,	202 15
Wachusett Aqueduct,	391 61
Wachusett Reservoir,	3,510 84
Wachusett electric power plant,	34,319 65
Sudbury system,	2,671 67
Sudbury electric power plant,	30,564 15
Distribution system,	1,716 21
Clinton sewerage system,	810 65
	74,319 25
Amount credited from beginning of work to January 1, 1917,	\$79,753 69
	1,312,937 18
Total receipts to January 1, 1918,	\$1,392,690 87

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate and buildings connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to \$355.56 and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
Joseph Hanreddy,	Contract 314, Section 7 of the Weston Aqueduct Supply Mains.	\$10 00
F. A. Mazzur & Co.,	Contract 332, for furnishing and installing a centrifugal pumping unit at the northern extra high service pumping station at Arlington, Mass.	1,650 00
Fred T. Ley & Co.,	Contract 385, for constructing an electric power transmission line between the Wachusett Power Station in Clinton, and the Sudbury Power Station in Southborough, Mass.	2,346 03

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Revere, Somerville and Woburn, and the towns of Arlington, Belmont, Reading, Stoneham, Wakefield, Winchester and Winthrop and parts of the city of Boston and the town of Lexington, — comprising in all 10 cities and 8 towns, with an area of 100.32 square miles. The district has an estimated population, based upon the census of 1915, as of December 31, 1917, of 633,220. Of the total population it is estimated that 89.7 per cent., or 568,075 people, contribute sewage to the North Metropolitan System.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Milton, Watertown and Wellesley, and parts of the city of Boston and the town of Dedham, — a total of 4 cities and 5 towns. This district has an area of 110.76 square miles, with an estimated population as of December 31, 1917, of 473,070. According to the estimates made 72.4 per cent. of this population, or 342,715, contribute sewage to the South Metropolitan System.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the North Metropolitan System during the past year was \$36,585.93.

The extension of the Deer Island outfall, authorized by chapter 344 of the Acts of 1914, has been completed and since the early days of December the sewage of the district has been discharged through the new openings.

A carefully contrived distribution of the effluent matters over a

considerable area at a distance below the surface of the harbor offers the best obtainable solution of the nuisance hitherto existing. So far as could be observed at this season of the year the method has been successful. The discharge of sewage from single outlets on the South Metropolitan High-level System near Peddock's Island at a considerable depth from the surface of the water has been free from objectionable odors and there is every reason for expecting results at least as favorable from the Deer Island outfalls, which are even more likely to mix thoroughly the sewage with large quantities of sea water than has been the case of the outlets near Peddock's Island.

By chapter 159 of the Acts of 1916 the town of Reading became a part of the North Metropolitan Sewerage District. The plans for the construction of the necessary connecting sewer have been made, but no contractor has been found who is willing to undertake its construction within the limits of the appropriation made for this purpose.

It cannot be necessary to call the attention of the Legislature to the unprecedented conditions which now attend the construction of work, public or private. Experienced contractors employed by this Board have lost large sums of money in the honest execution of their obligations by reason of the rapid increase in wages and in materials which are required by the work. These conditions, added to the well known uncertainties of any work at considerable depths below the surface of the ground, have made contractors reluctant to offer bids for public work, except at prices far beyond any which would have been thought extravagant a few months ago.

With all the evident disadvantages of the method of work upon a percentage basis, it seems to be at present the more direct path to a satisfactory and mutually fair result than any other that occurs to us.

By chapter 56 of the Resolves of the year 1917 the chairman of the Metropolitan Water and Sewerage Board, the Commissioner of Health of the State Department of Health, and the Commissioner of Public Works of the city of Boston, acting jointly, were authorized and directed to make an investigation relative to the sewage discharged into Boston Harbor and report the results with such recommendations as they might deem expedient to the General Court. This report has been made. The conclusions of that board

do not indicate that any part of such nuisances as may exist in Boston Harbor are the results of the discharge of sewage from the Metropolitan sewerage outlets.

The joint board, in concluding its report, points out that the State Department of Health is still engaged upon investigations upon the recovery of valuable products from sewage. These studies have been carried on for many years by the Massachusetts health authorities and have attracted the attention of all those whose opinions have value on this very important subject.

(2) NORTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The cost of the maintenance and operation of the North Metropolitan System during the past year was \$196,469.71.

Sewers and Pumping Stations.

The Metropolitan sewers in the North Metropolitan System now extend a distance of 63.942 miles, and the local sewers which are connected with the Metropolitan sewers have a further length of 769.92 miles, involving 84,182 connections.

The sewage of the North Metropolitan District flows at first by gravity, but before being finally disposed of is lifted at different points by pumping and is finally discharged into the harbor from an outfall off Deer Island.

The daily average amount of sewage discharged into the harbor was 64,600,000 gallons, a daily average for each person contributing sewage of 114 gallons. The decrease in the total amount of sewage discharged was 1,700,000 gallons per day less than the discharge of the preceding year. The maximum rate of discharge in any one day was 161,100,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island station (Boston Harbor),	4	235,000,000	19
East Boston station,	4	235,000,000	19
Charlestown station,	3	104,000,000	11 8
Alewife Brook station (Somerville),	3	22,000,000	13

There were purchased for the operation of the pumping stations 6,399 tons of bituminous coal and 196 tons of anthracite screenings, the average prices of which, at the different stations, varied from \$6.58 to \$10.29 per gross ton for the bituminous coal and from \$5.70 to \$6.72 for the screenings, delivered in the bins.

The amount expended for the stations was \$131,278.30. The average cost per million gallons of sewage lifted per foot at the several stations was \$0.159, an increase of 21 per cent. over the cost last year.

(3) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the South Metropolitan System during the past year was \$244,746.05.

The town of Wellesley was admitted to the South Metropolitan Sewerage District by chapter 343 of the Acts of 1914, and the act was accepted by the town in March, 1915.

The original estimate for the construction of the Wellesley extension, High-level sewer, of \$350,000, was made by the State Board of Health, and was based on a report submitted by an engineer called in by that department to make a survey and estimate. Two lines were considered by the Board of Health. The estimate was made on the shorter line which came through the location of the Brookline Water Works fields. This line was to connect with the existing Neponset Valley sewer of the High-level System at a point where the sewer has a capacity suitable only for the original district for which it was built.

Because of the small size of this existing Metropolitan sewer and the fact that this line extended across the Brookline Water Works fields and would interfere with this important supply, and also because of the fact that there is a rapidly growing portion of Dedham in the vicinity of Bridge Street which is a part of the Metropolitan District and has no possible means of reaching the Metropolitan System excepting by construction work by the Metropolitan Water and Sewerage Board, it was decided to use the alternate line proposed by the State Board of Health. This is somewhat longer but reaches the existing Metropolitan sewer at a point where the latter is of increased size and at the same time furnishes a means of outlet for the above-named portion of Dedham and obviates the difficulties in connection with our construction in the fields of the Brookline Water Works.

The Board has also designed a sewer of considerably larger capacity than was anticipated by the State Board of Health, feeling that the same is justified by the future demands of the District.

The line adopted has a length of about 40,000 feet almost wholly through private lands. The natural physical conditions in this part of the Charles River valley make sewer construction very expensive. This is occasioned by the large amount of rock encountered and by fine sands and other material in which it is expensive to construct and by the remoteness of the location.

Because of the above-stated conditions, namely, insufficiency of the original appropriation, not based on estimates made by the Metropolitan Water and Sewerage Board, and the necessary changes in the location to fit the needs of the District, the bad material encountered and, above all, the abnormal conditions of the market in regard to labor and supplies, an additional appropriation of \$325,000 was made by the Legislature of 1917. It is not probable that the remainder of this work, consisting of three sections of the nine into which the whole line was divided, can be completed within the appropriation. The contractor for one of the sections undertaken in the year 1917 found difficulties in carrying out his contract so serious that he felt obliged to abandon the work before any permanent construction of the sewer had been effected. The Board then took over the work under the oversight of a sewer builder of much experience and the undertaking has been successfully carried on under great difficulties and is now substantially completed, but at a very large increase in expense over the contract price.

Borings along the line of the proposed sewer were made in the usual manner and samples of the materials found in the borings were exhibited to those who proposed to bid for the work, but even experienced contractors misjudged the probable behavior of these materials and the cost of the work has far outrun the estimates.

An additional appropriation of \$200,000 has been asked for the completion of this sewer of which more than two-thirds has been finished, but even now the Board makes any estimate of probable cost with much hesitation.

The Board acquired by taking, during the year, easements in 1.2 acres of land in Dedham, for the construction of the Wellesley extension of the High-level sewer.

(4) SOUTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The entire cost of maintenance of the South Metropolitan System during the past year was \$131,929.28.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System, which comprise the old Charles River valley sewer and Neponset River valley sewer, as well as the new High-level sewer and extensions, have a total length of 49.069 miles, and with these are connected local sewers having a length of 653.17 miles, involving 45,149 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street station (Roxbury District),	2	100,000,000	45
Quincy station,	3	18,000,000	28
Quincy sewerage lifting station,	2	3,000,000	20

The sewage of two small areas in Dorchester and Milton, included in the Neponset River valley system, which are too low for sewage to be delivered into the High-level sewer by gravity, is, under an arrangement with the city of Boston, disposed of through the Boston Main Drainage Works at Moon Island. By this arrangement the Board is relieved from the expense of providing extra pumping facilities.

A large part of the sewage of the South District is lifted into the High-level sewer at the Ward Street pumping station in Roxbury. Most of the sewage of the city of Quincy is pumped into the High-level sewer at Greenleaf Street near the Quincy pumping station. All of the sewage of the South District is screened at the Nut Island screen-house for the purpose of intercepting solid matter, and is thence discharged at the bottom of the harbor from the outfalls about a mile off the island.

The daily average amount of sewage thus discharged was 60,200,000 gallons, and the largest rate of discharge in a single day was during a heavy storm, when the amount reached 162,000,000 gallons. The decrease in the daily average from last year was 1,800,000

gallons. The daily average discharge of sewage for each individual contributing sewage in the district was 176 gallons.

There were 2,890 gross tons of bituminous coal and 50 tons of anthracite screenings purchased at the two pumping stations and the Nut Island screen-house, the average prices of which varied from \$6.90 to \$10.60 per gross ton for the bituminous coal delivered in the bins. The screenings were purchased for \$6.72 per ton.

The total amount expended for the operation of the stations was \$72,876.51.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with November 30, 1917, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1917 is herewith presented, in accordance with the provisions of the act of 1906, as a part of the annual report of the Board.

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, the expenditures for construction, and the balances available on January 1, 1918, have been as follows: —

North Metropolitan System.

Loans authorized under various acts to January 1, 1918, for the construction of the North Metropolitan System and the various extensions,		\$7,521,365 73
Receipts from sales of real estate and from miscellaneous sources which are placed to the credit of the North Metropolitan System: —		
For the year ending December 31, 1917,	\$271 38	
For the period prior to January 1, 1917,	85,718 11	
		<hr/> 85,989 49
		<hr/> \$7,598,355 22
Amount carried forward,		\$7,598,355 22

Amount brought forward, \$7,598,355 22

Amount approved for payment by the Board¹ out of the Metropolitan Sewerage Loan Fund, North System:—

For the year ending December 31, 1917,	\$36,585 93	
For the period prior to January 1, 1917,	7,256,702 34	
		<u>7,293,288 27</u>

Balance, North Metropolitan System, January 1, 1918, . . \$305,066 95

South Metropolitan System.

Loans authorized under the various acts, prior to 1917, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions, constituting the South Metropolitan System, \$9,262,046 27

Loan authorized under General Acts of 1917, chapter 285 (for completing the extension of the Metropolitan Sewer to the Town of Wellesley), 325,000 00

Receipts from pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:—

For the year ending December 31, 1917,	\$83 88	
For the period prior to January 1, 1917,	19,300 45	
		<u>19,384 33</u>
		<u>\$9,606,430 60</u>

Amount approved by the Board for payment out of the Metropolitan Sewerage Loan Fund, South System:—

On account of the Charles River valley sewer, . . \$800,046 27

On account of the Neponset valley sewer, . . . 911,531 46

On account of the High-level sewer and extensions, including Wellesley extension:—

For the year ending December 31, 1917, \$244,746 05

For the period prior to January 1, 1917, 7,407,403 85

	<u>7,652,149 90</u>	
		<u>9,363,727 63</u>

Balance, South Metropolitan System, January 1, 1918, . . \$242,702 97

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

(2) TOTAL SEWERAGE DEBT, DECEMBER 31, 1917.

North Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3 and 3½ per cent.),	\$6,563,000 00
Serial bonds (3½ and 4 per cent.),	925,500 00
	<hr/>
Total bond issue to December 31, 1917,	\$7,488,500 00
Serial bonds paid prior to January 1, 1917,	\$48,500 00
Serial bonds paid in 1917,	26,500 00
	<hr/>
	75,000 00

Total bond issue outstanding December 31, 1917,	\$7,413,500 00
---	----------------

Gross Sewerage Debt,	\$7,413,500 00
Sinking fund December 31, 1917,	2,475,165 88

Net Sewerage Debt December 31, 1917,	\$4,938,334 12
--	----------------

A net increase for the year of \$67,389.87.

South Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3 and 3½ per cent.),	\$8,877,912 00
Serial bonds (4 per cent.),	395,000 00
	<hr/>
Total bond issue to December 31, 1917,	\$9,272,912 00
Serial bonds paid prior to January 1, 1917,	\$10,000 00
Serial bonds paid in 1917,	11,000 00
	<hr/>
	21,000 00

Total bond issue outstanding December 31, 1917,	\$9,251,912 00
---	----------------

Gross Sewerage Debt,	\$9,251,912 00
Sinking fund December 31, 1917,	1,450,626 87

Net Sewerage Debt December 31, 1917,	\$7,801,285 13
--	----------------

A decrease for the year of \$101,025.35.

(3) NORTH AND SOUTH METROPOLITAN LOAN AND SINKING FUNDS,
DECEMBER 31, 1917.

YEAR.	LOANS.		BONDS ISSUED (SINKING FUND).		BONDS ISSUED (SERIAL BONDS).		SINKING FUND.
	North System.	South System.	North System.	South System.	North System.	South System.	North and South Systems.
1889, . .	\$5,000,000 00	-	-	-	-	-	-
1890, . .	-	-	\$2,200,000	\$800,000	-	-	-
1891, . .	-	-	368,000	-	-	-	-
1892, . .	-	-	1,053,000	-	-	-	-
1893, . .	-	-	579,000	-	-	-	-
1894, . .	500,000 00	-	500,000	-	-	-	-
1895, . .	300,000 00	\$500,000 00	300,000	300,000	-	-	-
1896, . .	30,000 00	-	30,000	200,000	-	-	-
1897, . .	85,000 00	300,000 00	80,000	300,000	-	-	-
1898, . .	215,000 00	35,000 00	220,000	35,000	-	-	-
1899, . .	-	4,625,000 00	-	1,025,000	-	-	\$361,416 59
1900, . .	265,000 00	10,912 00 ¹	265,000	10,912	-	-	454,520 57
1901, . .	-	40,000 00	-	2,040,000	-	-	545,668 26
1902, . .	-	-	-	864,000	-	-	636,084 04
1903, . .	500,000 00	1,000,000 00	500,000	1,736,000	-	-	754,690 41
1904, . .	-	392,000 00	-	392,000	-	-	878,557 12
1905, . .	-	-	-	-	-	-	1,008,724 95
1906, . .	55,000 00	1,175,000 00	55,000	175,000	-	-	1,146,998 68
1907, . .	-	-	-	300,000	-	-	1,306,850 30
1908, . .	413,000 00	-	-	700,000	-	-	1,492,418 98
1909, . .	-	-	300,000	-	-	-	1,673,784 40
1910, . .	56,000 00	-	113,000	-	-	-	1,931,741 89
1911, . .	6,000 00	-	-	-	-	-	2,184,674 98
1912, . .	378,000 00	-	-	-	\$62,000	-	2,458,541 20
1913, . .	-	-	-	-	378,000	-	2,749,337 90
1914, . .	130,500 00	\$50,000 00	-	-	-	-	3,011,512 44
1915, . .	83,000 00	5,000 00	-	-	130,500	-	3,290,979 46
1916, . .	285,000 00	40,000 00	-	-	70,000	\$355,000	3,604,657 27
1917, . .	-	325,000 00	-	-	285,000	40,000	3,925,792 75
	\$8,301,500 00 ²	\$8,797,912 00	-	-	-	-	-
	789,134 27	789,134 27	-	-	-	-	-
	\$7,512,365 73	\$9,587,046 27	\$6,563,000	\$8,877,912	\$925,500	\$395,000	-

¹ The sum of \$10,912 was appropriated to reimburse the town of Watertown for the expense of constructing the Watertown siphon.

² Of this amount \$789,134.27 was expended for the construction of the Charles River valley sewer, which is now included in the South Metropolitan System.

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1917, were as follows: —

North Metropolitan System.

Appropriations as follows: —

Chapter 99, Special Acts of 1917,	\$195,000 00
Chapter 322, Special Acts of 1917,	1,000 00
Chapter 343, General Acts of 1917,	2,500 00
Chapter 374, Special Acts of 1917,	10,500 00
Receipts from pumping and from other sources,	250 41
	<hr/>
	\$209,250 41
Amount approved by the Board for payment,	196,469 71
	<hr/>
Balance, January 1, 1918,	\$12,780 70

South Metropolitan System.

Appropriations as follows: —

Chapter 100, Special Acts of 1917,	\$125,000 00
Chapter 343, General Acts of 1917,	2,500 00
Chapter 374, Special Acts of 1917,	6,500 00
Receipts from pumping and from other sources,	301 28
	<hr/>
	\$134,301 28
Amount approved by the Board for payment,	131,929 28
	<hr/>
Balance, January 1, 1918,	\$2,372 00

(5) SEWER ASSESSMENTS, 1917.

The following sewer assessments were made by the Treasurer of the Commonwealth upon the various municipalities: —

North Metropolitan Sewerage System.

Sinking fund requirements,	\$114,807 52
Serial bonds,	21,606 00
Interest,	227,005 76
Maintenance: —	
Appropriated by Legislature,	\$209,000 00
Less balance on hand,	16,027 22
	<hr/>
	192,972 78
	<hr/>
Total North Metropolitan sewerage assessment,	\$556,392 06

South Metropolitan Sewerage System.

Sinking fund requirements,	\$71,331 29
Serial bonds,	9,389 20
Interest,	309,228 23
Maintenance:—	
Appropriated by Legislature,	\$134,000 00
Less balance on hand,	4,845 36
	<hr/>
	129,154 64
Total South Metropolitan sewerage assessment,	\$519,103 36

In accordance with the provisions of chapter 369, Acts of 1906, the proportion to be paid by each city and town to meet the interest and sinking fund requirements for each year is based upon their respective taxable valuations, and to meet the cost of maintenance and operation upon their respective populations.

The divisions of the assessments for 1917 were as follows:—

North Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$16,274 29	Reading, ¹	\$5,051 52
Belmont,	10,493 59	Revere,	21,904 50
Boston,	86,378 26	Somerville,	74,814 24
Cambridge,	119,189 91	Stoneham,	6,121 29
Chelsea,	32,918 90	Wakefield,	11,819 32
Everett,	32,246 34	Winchester,	14,946 29
Lexington,	5,617 61	Winthrop,	14,162 24
Malden,	43,253 88	Woburn,	14,486 46
Medford,	29,066 20	Total,	\$556,392 06
Melrose,	17,657 22		

¹ Reading is also assessed \$7,000 for sinking fund requirements in accordance with section 5, chapter 159, General Acts of 1916.

South Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Boston,	\$235,799 31	Quincy,	\$35,572 23
Brookline,	98,199 48	Waltham,	26,182 68
Dedham,	11,858 16	Watertown,	16,825 40
Milton,	21,585 77	Wellesley, ¹	10,918 57
Newton,	62,161 76	Total,	\$519,103 36

¹ Wellesley is also assessed \$6,775.24 for sinking fund requirements in accordance with section 5, chapter 343, Acts of 1914.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1917.
NORTH METROPOLITAN SYSTEM.	
North System, enlargement: —	
Administration,	\$2,425 54
Deer Island Outfall extension,	28,561 87
Removal of old Malden River siphon,	1,052 86
Reading extension,	4,545 66
	\$36,585 93
Amount charged from beginning of work to January 1, 1917,	7,256,702 34
Total for North Metropolitan System to January 1, 1918,	\$7,293,288 27
SOUTH METROPOLITAN SYSTEM.	
High-level sewer extensions: —	
Administration,	\$3,620 85
Relief Outfall, Section 43,	200 00
Wellesley extension: —	
Section 98,	\$145,249 20
Section 99,	2,292 18
Section 100,	1,721 71
Section 101,	2,529 74
Section 102,	52,178 05
Section 103,	6,934 98
Section 104,	11,980 70
Section 105,	114 14
Section 106,	584 16
Real estate settlements,	4,000 00
Legal, conveyancing and expert,	326 02
Payments under Industrial Accident Law and special benefit appropriations,	98 00
	228,008 88
Additions to Ward Street pumping station plant,	12,916 32
	\$244,746 05
Amount charged from beginning of work to January 1, 1917,	9,118,981 58
Total for South Metropolitan System to January 1, 1918,	\$9,363,727 63
Total for construction, both systems,	\$16,657,015 90
MAINTENANCE AND OPERATION.	For the Year ending December 31, 1917.
North Metropolitan System,	\$196,469 71
South Metropolitan System,	131,929 28
Total for maintenance, both systems,	\$328,398 99

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1917: —

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1917.	
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. <i>North System Enlargement.</i>		
Administration: —		
Commissioners,	\$1,166	87
Secretary,	375	00
Clerks and stenographers,	508	16
Stationery, printing and office supplies,	138	33
Telephone, lighting, heating, water and care of building,	136	41
Rent and taxes, main office,	100	97
	\$2,425 54	
Engineering: —		
Chief engineer,	\$625	01
Engineering assistants,	6,675	84
Inspectors,	1,128	81
Traveling expenses,	141	08
Stationery, printing and office supplies,	110	22
Engineering and drafting instruments and tools,	6	70
Engineering and drafting supplies,	92	38
Telephone, lighting, heating, water and care of building,	409	26
Rent and taxes,	302	93
Miscellaneous expenses,	325	88
	9,818 11	
Tools, machinery and appliances,	\$46	55
Brick, cement, lumber and other field supplies and expenses,	365	83
	412 38	
Contracts: —		
George M. Bryne, Contract 131, for constructing Section 1A of the Deer Island Temporary Outfall sewer extension,	\$7,167	49
Roy H. Beattie Inc., Contract 135, for constructing Section 1 of the Deer Island Outfall sewer extension in Boston Harbor,		
	16,752	41
	23,919 90	
Real estate: —		
Legal, conveyancing and expert,	\$10	00
	10 00	
Total for North Metropolitan System,	\$36,585 93	

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1917.
SOUTH METROPOLITAN SYSTEM.		
High-level Sewer Extensions.		
Administration:—		
Commissioners,	\$1,166 66	
Secretary,	375 00	
Clerks and stenographers,	1,435 62	
Stationery, printing and office supplies,	324 30	
Telephone, lighting, heating, water and care of building,	173 81	
Repairs of building,	25	
Rent and taxes, main office,	144 21	
Miscellaneous expenses,	1 00	
		\$3,620 85
Engineering:—		
Chief engineer,	\$416 67	
Engineering assistants,	6,705 19	
Inspectors,	8,176 76	
Traveling expenses,	762 51	
Engineering and drafting instruments and tools,	18 95	
Stationery, printing and office supplies,	187 06	
Engineering and drafting supplies,	122 76	
Telephone, lighting, heating, water and care of building,	521 53	
Repairs of building,	75	
Rent and taxes, main office,	432 75	
Miscellaneous expenses,	618 52	
		17,963 45
Advertising,	\$66 40	
Labor and teaming,	4,575 43	
Tools, machinery and appliances,	4,550 43	
Brick, cement, lumber and other field supplies and expenses,	5,773 76	
		14,966 02
Contracts:—		
Bay State Dredging and Contracting Co., Contract 133, for constructing Section 104 of the High-level sewer (Wellesley extension) in Needham,	\$10,784 99	
Bruno & Petitti, Contract 134, for constructing Section 103 of the High-level sewer (Wellesley extension) in Needham,	5,501 25	
Bruno & Petitti, Contract 143, for constructing Section 102 of the High-level sewer (Wellesley extension) in Needham,	42,982 61	
George M. Bryne, under agreement dated October 23, 1916, for constructing Section 98 of the High-level sewer (Wellesley extension) in West Roxbury and Dedham,	133,459 44	
George M. Bryne, under agreement dated October 6, 1917, for constructing Section 99 (in part) of the High-level sewer (Wellesley extension) in Dedham,	1,683 42	
D. M. Dillon Steam Boiler Works, Contract 136, for furnishing two vertical fire tube boilers for the Ward Street pumping station of the South Metropolitan Sewerage System in Roxbury,	9,160 00	
W. H. Ellis & Son Co., Contract 120, for constructing part of Section 43, Relief Outfall line of the High-level sewer in Boston Harbor,	200 00	
		203,771 71
Payments under Industrial Accident Law and special benefit appropriations,	\$98 00	
		98 00
Real estate:—		
Legal, conveyancing and expert,	\$326 02	
Settlements,	4,000 00	
		4,326 02
Total for South Metropolitan System,		\$244,746 05

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1917.	
MAINTENANCE AND OPERATION OF WORKS. North Metropolitan System.			
Administration: —			
Commissioners,		\$2,708 33	
Secretary and assistants,		2,569 05	
Rent,		259 65	
Heating, lighting and care of building,		288 75	
Repairs of building,		5 50	
Postage,		60 00	
Printing, stationery and office supplies,		430 64	
Telephones,		42 43	
Miscellaneous expenses,		30 05	
			\$6,394 40
General supervision: —			
Chief engineer and assistants,		\$6,088 29	
Rent,		778 95	
Heating, lighting and care of building,		866 36	
Repairs of building,		16 50	
Printing, stationery and office supplies,		87 01	
Telephones,		127 32	
Miscellaneous expenses,		6 50	
			7,970 93
Deer Island pumping station: —			
Labor,		\$21,372 09	
Fuel,		17,517 71	
Oil and waste,		431 23	
Water,		1,657 20	
Packing,		98 34	
Repairs and renewals,		973 09	
Telephones,		25 75	
General supplies,		632 01	
Miscellaneous supplies and expenses,		742 41	
			43,449 83
East Boston pumping station: —			
Labor,		\$21,991 56	
Fuel,		19,453 35	
Oil and waste,		705 04	
Water,		1,570 80	
Packing,		93 27	
Repairs and renewals,		1,053 69	
Telephones,		3 25	
General supplies,		336 69	
Miscellaneous supplies and expenses,		244 33	
			45,451 98
Charlestown pumping station: —			
Labor,		\$18,064 14	
Fuel,		8,003 08	
Oil and waste,		213 62	
Water,		957 12	
Packing,		47 43	
Repairs and renewals,		310 59	
Amounts carried forward,		\$27,595 98	\$103,267 14

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1917.	
<i>Amounts brought forward,</i>	\$27,595 98	\$103,267 14
<i>North Metropolitan System — Con.</i>		
Charlestown pumping station — <i>Con.</i>		
Telephones,	47 87	
General supplies,	375 81	
Miscellaneous supplies and expenses,	181 96	
		28,201 62
Alewife Brook pumping station: —		
Labor,	\$9,057 81	
Fuel,	4,283 61	
Oil and waste,	172 18	
Water,	175 08	
Packing,	21 31	
Repairs and renewals,	299 89	
Telephones,	28 06	
General supplies,	71 61	
Miscellaneous supplies and expenses,	65 32	
		14,174 87
Sewer lines, buildings and grounds: —		
Engineering assistants,	\$2,100 00	
Labor,	34,454 91	
Brick, cement and lime,	753 14	
Castings, ironwork and metals,	607 52	
Freight, express and teaming,	10 00	
Fuel and lighting,	64 10	
Jobbing and repairing,	154 38	
Lumber,	1,155 09	
Machinery, tools and appliances,	258 90	
Paints and oils,	421 82	
Rubber and oiled goods,	318 33	
Telephones,	37 50	
Traveling expenses,	854 29	
General supplies,	1,013 21	
Miscellaneous expenses,	43 65	
		42,246 84
Horses, vehicles and stable account,		4,437 48
Payments under Industrial Accident Law and special benefit appropriations,		3,143 00
Investigation Sucker Brook Sewer (ch. 322, Acts of 1917),		998 76
Total for North Metropolitan System,		\$196,469 71
<i>South Metropolitan System.</i>		
Administration: —		
Commissioners,	\$1,541 67	
Secretary and assistants,	2,331 23	
Rent,	187 52	
Heating, lighting and care of building,	199 94	
Repairs of building,	5 50	
Postage,	50 00	
Printing, stationery and office supplies,	312 97	
<i>Amount carried forward,</i>	\$4,628 83	

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1917.
<i>Amount brought forward,</i>	\$4,628 83
<i>South Metropolitan System — Con.</i>	
<i>Administration — Con.</i>	
Telephones,	20 60
Traveling expenses,	15 25
Miscellaneous expenses,	27 35
	\$4,692 03
General supervision: —	
Chief engineer and assistants,	\$5,133 36
Rent,	562 58
Heating, lighting and care of building,	599 94
Repairs of building,	16 50
Printing, stationery and office supplies,	279 73
Postage,	10 00
Telephones,	61 83
Traveling expenses,	50 00
Miscellaneous expenses,	1 25
	6,715 19
Ward Street pumping station: —	
Labor,	\$24,568 93
Fuel,	14,670 33
Oil and waste,	315 45
Water,	1,536 00
Packing,	345 02
Repairs and renewals,	1,973 86
Telephones,	45 31
General supplies,	1,289 72
Miscellaneous supplies and expenses,	164 91
	44,909 53
Quincy pumping station: —	
Labor,	\$9,112 41
Fuel,	2,172 56
Oil and waste,	76 62
Water,	295 85
Packing,	25 47
Repairs and renewals,	137 90
Telephones,	27 37
General supplies,	394 72
Miscellaneous supplies and expenses,	55 39
	12,298 29
Nut Island screen-house: —	
Labor,	\$9,237 35
Fuel,	4,908 03
Oil and waste,	125 90
Water,	511 82
Packing,	26 75
Repairs and renewals,	173 50
Telephones,	33 44
General supplies,	583 79
Miscellaneous supplies and expenses,	68 11
	15,668 69
<i>Amount carried forward,</i>	\$84,283 73

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31 1917.
<i>Amount brought forward,</i>	\$84,283 73
<i>South Metropolitan System — Con.</i>	
Sewer lines, buildings and grounds: —	
Engineering assistants,	\$3,925 00
Labor,	26,793 00
Automobiles,	556 94
Brick, cement and lime,	759 60
Castings, ironwork and metals,	252 22
Fuel and lighting,	403 05
Freight, express and teaming,	90 00
Jobbing and repairing,	15 10
Lumber,	1,934 25
Machinery, tools and appliances,	141 06
Paints and oils,	219 71
Rubber and oiled goods,	162 48
Sand, gravel and stone,	186 92
Telephones,	24 58
Traveling expenses,	636 73
General supplies,	365 11
Miscellaneous expenses,	553 24
	37,018 99
City of Boston, for pumping,	7,407 52
Horses, vehicles and stable account,	3,219 04
Total for South Metropolitan System,	\$131,929 28

(b) Receipts.

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

ACCOUNT.	For the Year ending December 31, 1917.
Construction: —	
North Metropolitan System,	\$271 33
South Metropolitan System,	83 83
Maintenance: —	
North Metropolitan System,	250 41
South Metropolitan System,	301 28
Sinking fund: —	
North Metropolitan System,	116 65
South Metropolitan System,	8,045 00
Interest fund: —	
North Metropolitan System,	29 32
South Metropolitan System,	31 78
	\$9,129 70
Amount credited from beginning of work to January 1, 1917,	129,649 10
Total receipts to January 1, 1918,	\$138,778 80

(c) Assets.

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate connected therewith.

(d) Liabilities.

There are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level sewer extensions:— . . .		
Timothy J. O'Connell,	Contract 57, Section 82, in part,	\$60 00
Bruno & Petitti,	Contract 143, Section 102, Wellesley extension, .	9,912 21
North System enlargement:—		
Roy H. Beattie, Inc.,	Contract 135, Section 1, Deer Island Outfall sewer extension.	6,581 09

Settlements are pending with the following parties for easements taken in lands owned by them:—

F. Murray Forbes, Hugh D. Scott, Charles H. Harmon, Clifford M. Locke, Martha W. Burrage, Needham Tire Co., Anne Williams, John Wells Farley, I. Tucker Burr, Jr., Edward and Catherine Bingham, Hannah Bingham, Katherine H. Rooney, Mary A. Read, J. Austin Amory, Hannah E. Pond, Richard G. Wadsworth, Charles Philip Beebe, John T. Morse, Jr., Mary A. Sidney, Frank D. Chase, Devises of Anna E. Chase, Stephen M. Weld.

VIII. RECOMMENDATIONS FOR LEGISLATION.

In the abstract of the annual report for the year 1917 the Board made the following statement and recommendations:—

On account of the high price of labor and materials, resulting from the unusual business conditions that have prevailed during the past year, a large

portion of the construction work already authorized has been deferred with the hope of carrying out the projects under more favorable conditions.

There is a balance of \$4,000 now remaining from the appropriation of \$600,000 authorized by chapter 694 of the Acts of 1912 for the purchase of certain property from the City of Boston; and in view of the uncertainty regarding the cost of construction work at the present time and the possibility that new expenditures may be required for the East Boston service, the Board recommends that authority be given to use this balance for such new expenditures and for the increased cost of constructing a line for the transmission of electricity between the power station at the Wachusett Dam in Clinton and the power station at the Sudbury Dam in Southborough; to relocate and connect meters for the measuring of water supplied through the low service to the Metropolitan Water District; to construct a 12-inch pipe line in Poplar Street, West Roxbury, and under the Neponset River; and to install a new pumping engine at the Arlington pumping station, authorized under chapter 172 of the General Acts of the year 1916, due to the present increase in cost of labor and materials.

The original estimate for the construction of the Wellesley extension, High-level sewer, of \$350,000, was made by the State Board of Health, and was based on a report submitted by an engineer called in by that department to make a survey and estimate. Two lines were considered by the Board of Health. The estimate was made on the shorter line which came through the location of the Brookline Water Works fields. This line was to connect with the existing Neponset Valley sewer of the High-level System at a point where the sewer has a capacity suitable only for the original district for which it was built.

Because of the small size of this existing metropolitan sewer and the fact that this line extended across the Brookline Water Works fields and would interfere with this important supply, and also because of the fact that there is a rapidly growing portion of Dedham in the vicinity of Bridge Street, which is a part of the Metropolitan District and has no possible means of reaching the metropolitan system except by construction work by the Metropolitan Water and Sewerage Board, it was decided to use the alternate line proposed by the State Board of Health. This is somewhat longer but reaches the existing metropolitan sewer at a point where the latter is of increased size and at the same time furnishes a means of outlet for the above-named portion of Dedham and obviates the difficulties in connection with our construction in the fields of the Brookline Water Works.

The Board has also designed a sewer of considerably larger capacity than was anticipated by the State Board of Health, feeling that the same is justified by the future demands of the District.

The line adopted has a length of about 40,000 feet almost wholly through private lands. It has been divided into sections numbered from 98 to 106, inclusive. At the present time sections 102, 103, 104, 105 and 106 are wholly completed. Section 98 is under construction and nearly completed.

The natural physical conditions of this part of the Charles River valley make sewer construction very expensive. This is occasioned by the large amount of rock encountered and by fine sands and other material in which it is expensive to construct and by the remoteness of the location.

Because of the above-stated conditions, namely, insufficiency of the original appropriation, not based on estimates made by the Metropolitan Water and Sewerage Board, and the necessary changes in the location to fit the needs of the District, the bad material encountered and, above all, the abnormal conditions of the market in regard to labor and supplies, it is necessary that an additional appropriation be asked for to complete the work.

Following is the cost of the completed sections with an estimate of the cost of the remaining ones:—

SECTION.		Cost.	Length (Feet).
98	80 per cent. completed,	\$157,000	3,350
	20 per cent. to be completed,	40,000 ¹	
99,	. . . . .	149,000 ¹	3,300
100,	. . . . .	110,000 ¹	3,700
101,	. . . . .	80,000 ¹	3,950
102,	. . . . .	81,000	6,851
103,	. . . . .	45,900	5,916
104,	. . . . .	74,000	4,300
105,	. . . . .	44,000	4,425
106,	. . . . .	43,800	4,355
Administration, land damages and engineering to date,		36,000	-
Total cost accrued and estimated,		\$860,500	40,147

¹ Estimated.

showing that the probable cost of construction work on this line will amount to \$860,500, including engineering and incidentals. To this must be added the cost of land damage and any settlements of outstanding claims by contractors. The Board, therefore, asks for an additional appropriation of \$200,000.

The Legislature of 1916 appropriated \$285,000 for the purpose of connecting the town of Reading with the North Metropolitan Sewerage System. During the past year estimates were obtained from trustworthy contractors of the expense of constructing a portion of this line. These estimates made it evident that under present conditions the amount of \$285,000 appropriated by the Legislature for this purpose would be entirely insufficient to complete the work. An estimate has recently been made by a trustworthy contractor of the amount of money necessary to construct the whole of this sewer. This estimate is in round numbers \$700,000. In the opinion of the Board it is not probable that any contractor of sufficient ability to complete the work will be willing to undertake it at a lower price. The Board, therefore, if the Legislature deems it wise to enter upon this work, asks for an additional appropriation of \$415,000. In presenting this estimate the Board desires to add the expression of its opinion that any estimate made at this time may prove deceptive.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY P. WALCOTT,
EDWARD A. McLAUGHLIN,
THOMAS E. DWYER,
Metropolitan Water and Sewerage Board.

Boston, February 27, 1918.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:— I have the honor to submit a report of the work done in connection with the construction, maintenance and operation of the Metropolitan Water Works for the year ended December 31, 1917.

ORGANIZATION.

The organization of the force employed under the direction of the Chief Engineer has remained the same as during the previous year. The principal assistants are as follows:—

John L. Howard, . . .	Assistant to the Chief Engineer.
Elliot R. B. Allardice, . . .	Superintendent of Wachusett Department.
Charles E. Haberstroh, . . .	Superintendent of Sudbury Department.
Samuel E. Killam, . . .	Superintendent of Distribution Pipe Lines and Reservoirs.
Arthur E. O'Neil, . . .	Superintendent of Distribution Pumping Stations.
Alfred O. Doane, . . .	Division Engineer, in charge of Mechanical Engineering and Inspection Work.
William W. Locke, . . .	Sanitary Inspector, in charge of Sanitary Inspection of Watersheds.
Clifford Foss, . . .	Assistant Engineer, in charge of Distribution Civil Engineering.
Benjamin F. Hancox, . . .	Head Draftsman, in charge of Drafting Force.
James W. Killam, . . .	Assistant Engineer, in charge of Coal and Oil Laboratory and compilation of Pumping Statistics.
William E. Whittaker, . . .	Office Assistant, in charge of General Office and compilation of Water Supply Statistics.
Charles E. Livermore, . . .	Biologist, in charge of Microscopical and Bacteriological Examinations of the Water Supply.

Including these principal assistants the number of supervising, engineering and clerical employees was 47 at the beginning of the

year. As a result of the unusual demands for engineers, clerks and stenographers, 15 experienced employees of this class resigned during the year to accept positions with increased compensation elsewhere, and one enlisted in the United States Navy. On account of the difficulty of replacing these employees under the existing conditions, seven of the vacancies had not been filled at the close of the year.

In addition to the office forces, the labor forces engaged in maintaining and operating the reservoirs, aqueducts, pipe lines, hydro-electric stations and pumping stations and doing minor construction work have been as follows:—

DEPARTMENT.	Beginning of Year.	End of Year.	Maximum.	Average.
Wachusett,	42	49	76	57
Sudbury,	57	82	95	78
Distribution, pipe lines and reservoirs,	78	91	104	88
Distribution, pumping service,	56	61	63	61
	233	283	338	284

During the year 21 employees have been mustered into the United States service from the labor forces.

CONSTRUCTION.

DEFERRED PROJECTS.

On account of the high prices of labor and materials and lack of additional appropriation, the work of improving Beaver Dam Brook, which was authorized by chapter 814 of the Acts of the year 1913, and of laying a 12-inch pipe line in Poplar Street, West Roxbury, and under the Neponset River in Hyde Park, and a 16-inch pipe line in Arlington, authorized by chapter 172 of the General Acts of the year 1916, was not undertaken during the year.

Proposals were received on June 15 for the 36-inch pipes and special castings required for laying the additional supply main in Chelsea for the East Boston low service, which was authorized by chapter 322 of the General Acts of the year 1917. Revised estimates, based on these proposals, showed that the cost of the pipe line would exceed the appropriation by about \$5,640, and the work

was not undertaken. Opportunity was taken, however, during the year, in connection with the repaving of Williams Street by the city of Chelsea, to relay 170 linear feet of the 20-inch pipe line where it crosses over the 24-inch pipe line. This work has removed an objectionable crossing of the two existing supply mains and increased the reliability of the service.

WACHUSETT-SUDBURY POWER TRANSMISSION LINE.

During 1916 the preliminary engineering work in connection with the preparation of the plans for the Wachusett-Sudbury power transmission line was completed, and 177 chestnut poles 40 to 50 feet in length were cut on the water works lands for use in its construction. The line will be used for furnishing electric energy to the New England Power Company and the Edison Electric Illuminating Company of Boston. These companies have contracted, jointly, to purchase all of the electric energy to be generated at the Wachusett power station for a period of ten years from the completion of the transmission line, which is being constructed from a point near the Wachusett power station in Clinton to a point near the Sudbury power station in Southborough. It is located on lands owned by the Commonwealth situated in the towns of Clinton, Berlin, Northborough and Southborough and the city of Marlborough, and includes 15.59 miles of single circuit electric power transmission line for 3-phase, 66,000-volt alternating current, with two telephone conductors below the three power conductors for a distance of 15.25 miles. Except for a distance of 840 feet, where a location was purchased in order to shorten the line about 1,300 feet, and an easement about 67 feet in length at the crossing of the New York, New Haven & Hartford Railroad in Southborough, the line is located on lands acquired for the construction of the Wachusett Aqueduct and the Sudbury Reservoir. The transmission line crosses the waste channel and the valley below the Wachusett Dam, the Assabet River beside the Wachusett Aqueduct bridge, the open channel portion of the Wachusett Aqueduct in two places, the Sudbury Reservoir in three places, steam railways at four places and twenty-seven highways.

On account of the advantage of following the aqueduct location which was already acquired and of the numerous highway, railroad, river and reservoir crossings, several types of construction were

necessary, including 14 steel towers, 12 double-pole structures, 34 pull-off poles and 354 single poles.

The steel towers were used at the three spans near the Wachusett Dam, at the steam railroad crossings and at the two long spans over the Sudbury Reservoir. They are made up of structural steel; ten of them are approximately 48 feet in height and 9 feet square at the base, and four are approximately 68 feet in height and 12 feet square at the base. Chestnut poles from 40 to 55 feet in length were used for the remainder of the line, spaced about 200 feet apart and standing from 34 feet to 47½ feet in height above the ground. There are 412 chestnut poles in the entire line; 200 of them were cut on water works land by the department forces and delivered to the contractor for use in the line without charge therefor. The department forces also cleared the location for the transmission line, where necessary, for a width of 50 feet and a total length of about 7 miles, and laid 605 linear feet of 2-inch Orangeburg fibre conduit easterly from the Wachusett power station for the underground telephone cables.

At the crossings over the Assabet River and open channel, at several highways and at deflection angles over 30 degrees, double-pole structures were used. At most deflection angles of between 10 and 30 degrees pull-off poles were used and at deflection angles of less than 10 degrees the regular single poles, properly guyed, were used.

The power conductors are 3-strand, medium hard-drawn bare copper cables of No. 2 American wire gage, except for a distance of 1,594 feet for the three spans near the Wachusett Dam, where No. 00 American wire gage 7-strand cable is used, and the center strand is of soft copper.

The long span at the Wachusett Dam is 984 feet and the two long spans over the Sudbury Reservoir are 685 feet and 753 feet, respectively.

The telephone conductors are bare galvanized wire of No. 6 Birmingham wire gage, except at the two long spans over the Sudbury Reservoir where they are No. 4 Birmingham wire gage.

One complete transposition of the power conductors is made by a one-third roll at three points in the line, and the telephone conductors are transposed at every fourth pole.

The power line insulators are of porcelain for 66,000-volt service

and are of the pin type on single-pole arms and pole-top brackets and of the suspension type on pull-off poles, double-pole structures and towers. The telephone line insulators are of porcelain for 13,000-volt service.

The regular cross-arms for the power conductors are 6 feet 6 inches long, built up of two 4-inch galvanized structural steel channels with the necessary plates and angles, and for the telephone conductors they are 3 feet long of $3\frac{1}{4}$ -inch x $4\frac{1}{4}$ -inch prime quality long-leaf yellow pine timber.

The regular arrangement of the power conductors is in triangular formation spaced 6 feet apart on single poles and 10 feet apart at the steel towers. At highway crossings the lowest power conductor is at least 28 feet above the roadway and at least 8 feet above any cross wires.

All poles were brush treated with two coats of creosote oil applied at a temperature of 150 degrees Fahrenheit at all scars, knots, gains, roofs and butts, and all wooden cross-arms and wooden anchors were treated all over in a similar manner. For a distance of 11 miles from the westerly end of the line the poles were treated for 2 feet above and 2 feet below the ground line with two coats of creosote oil, and for the remainder of the line the oil was omitted and the entire base of the poles was charred below a point 2 feet above the ground line, using large kerosene blow torches for this work. At every pole structure a galvanized steel ground cable $\frac{3}{8}$ of an inch in diameter was coiled six times on the face of the butt, extended up the pole and connected with the power cross-arm and pole top pin.

A contract was made July 28 with Fred T. Ley & Company, Incorporated, of Springfield, Mass., the lowest bidder for constructing the transmission line. Work was begun by the contractor September 10 and was continued until the end of the year. The force employed averaged about 25 men and 2 horses.

The total expenditures for the transmission line to December 31, 1917, amounted to \$19,234.14.

The work remaining to be done at the close of the year includes some field riveting on the steel towers, placing the insulators, stringing the conductors and the final painting of the poles and towers.

At the close of the year the New England Power Company had completed its 66,000-volt connecting line which extends about 1.7

miles westerly from the westerly terminus of our line to the Company's sub-station in Clinton. As this sub-station is already connected with the Wachusett power station by two 13,200-volt lines no direct connection will be made between the new 66,000-volt line and the Wachusett power station, but a connection will be made with the Sudbury power station early in the spring.

The connecting 66,000-volt line to be provided by the Edison Electric Illuminating Company of Boston will extend from the easterly terminus of our line for a distance of several miles to one of its sub-stations. As work had not been begun by the Company on its line at the close of the year work on our line will be suspended as soon as the riveting of the steel towers is completed and the remaining work will be deferred until the early spring.

ADDITIONAL NORTHERN HIGH-SERVICE PIPE LINE AND PUMPING MACHINERY.

The work of installing at the northern extra high-service pumping station in Arlington a steam turbine driven centrifugal pumping unit of a capacity of 3,000,000 gallons in 24 hours and a return tubular boiler 54 inches in diameter x 17 feet in length, provided for by chapter 172 of the General Acts of the year 1916, has been continued. Proposals for the pumping unit were opened March 22, and after a careful examination of the propositions submitted a contract was made with F. A. Mazzur & Company of Boston to furnish and install for the sum of \$9,000 a unit consisting of a steam turbine to be made by the Moore Steam Turbine Corporation of Wellsville, N. Y., centrifugal pumps to be made by the Allis-Chalmers Company of Milwaukee, Wis., and a horizontal cylindrical condenser of the water works type and a Wheeler-Edwards type air pump to be made by the Wheeler Condenser & Engine Company of Carteret, N. J.

Owing to war-time conditions there has been considerable delay in delivering the machinery. The steam turbine was tested at the shop on October 1 and was delivered at the pumping station on October 25. The centrifugal pumps were tested at the shop on August 22, but owing to some minor changes necessary to comply with the specifications were not delivered at the pumping station until December 18. The condenser and air pump were inspected at the shop on December 19 and were shipped December 28, but had not been received at the end of the year.

The concrete foundation for the unit was constructed by the department forces and at the close of the year the contractor had set the turbine and pumps on the foundation but had not lined them up in final position.

Pipes and fittings for the discharge and suction piping and for the new steam main were purchased and have been received, and a portion of the suction piping has been laid.

A contract for making and delivering at the pumping station the boiler with smoke box, up-take extension of existing flue, cast-iron front and I beam supports was made with the New England Iron Works Company of South Boston on May 15 for the sum of \$2,296.

After considerable delay, due to the abnormal condition of the steel business, the contractor received the steel from the mill on October 4, and on account of further delay at the contractor's shop the boiler is only 80 per cent. completed at the end of the year.

A 14-inch Coppus blower is to be installed with the new boiler and a 12-inch Coppus blower has been installed on one of the existing boilers to furnish forced draft, so that a large percentage of anthracite screenings may be burned at this station in the future.

A Westinghouse locomotive-type air compressor, with steam cylinder $9\frac{1}{2}$ inches in diameter and air cylinder $7\frac{1}{2}$ inches in diameter and a stroke of 10 inches, was installed for use in place of the large suction air chamber which it was necessary to remove to provide for the new suction piping.

Plans for the proposed 16-inch pipe line to extend from the northern extra high-service stand-pipe in Arlington to the Lexington boundary line have been completed, but, owing to the continued high price of cast-iron pipe and special castings, the construction of this line has been again deferred until it can be done under more economical conditions.

The expenditures for these improvements to December 31, 1917, amount to \$7,637.00, of which \$314.64 was for the pipe line and \$7,322.36 for the pumping station.

METERS AND CONNECTIONS.

To provide for satisfactory operation of the supply mains acquired from the city of Boston in 1913, the work of relocating the Venturi meters and of making additional connections under the provisions of chapter 172 of the General Acts of the year 1916, which was begun in 1916, has been continued during the year 1917.

The work of installing a 30-inch x 10-inch Venturi meter, 30-inch check valve and 12-inch blow-off connection in Perkins Street at the Boston-Somerville boundary line, which was suspended at the close of the year 1916 on account of the unfavorable weather, was resumed early in 1917 and the meter was put into service April 4. The blow-off pipe was laid and the entire work was completed during the following month. The total expenditure for all work at this place amounts to \$2,895.18, including the expenditure made in 1916.

In May and June the 48-inch x 22½-inch Venturi meter in the former Boston Water Works Beacon Street line near effluent gate-house No. 1 at Chestnut Hill Reservoir in Boston, was taken up, and after substituting an 18-inch throat section for the 22½-inch, the meter was installed in the Beacon Street main at St. Mary's Street in Brookline, at the Boston boundary line. A 48-inch check valve and a 12-inch blow-off connection were installed at this place and the 48-inch meter was put into service again on June 15. A 36-inch gate valve and 48-inch manhole pipe were installed in the 48-inch pipe line near effluent gate-house No. 1 at the point where the meter had been removed, and in connection with this work the interior surface of the 48-inch main was cleaned for a distance of 325 feet and for a length of 50 feet was given two coats of red lead and linseed oil paint. The total expenditures for removing and re-locating the meter and doing all other work in connection therewith was \$5,914.33.

In June and July a 16-inch gate valve was set in the former Boston Water Works 24-inch main in Broadway, Somerville, at the Boston boundary line, and a 10-inch x 3¾-inch Venturi meter, a 10-inch gate valve, 10-inch check valve and 8-inch blow-off connection were installed on the by-pass around the 16-inch valve. The meter was put into service on July 18 but the blow-off pipe has not been connected with the sewer. The total expenditures for this work amount to \$1,767.67.

September 13 work was begun on the connection between the former 30-inch Boston Water Works main, the Metropolitan Water Works 48-inch main and the Boston Water Works 24-inch main in Perkins Street, at Prince Street in Boston, near the Brookline boundary line, and in connection with this work a 30-inch x 12-inch Venturi meter was moved from the old Brookline Reservoir grounds

on October 29 and installed at Perkins Street, so that it will measure all of the water delivered to the city of Boston from both the 30-inch and the 48-inch mains. A 30-inch check valve and 8-inch blow-off connection were also installed at this place. The meter was again placed in service on November 10 and the entire work was completed on December 4. The total expenditures for this work amount to \$4,926.00.

In August a branch pipe line was laid from the 30-inch low-service main near the old Mystic pumping station to the Alewife Brook Parkway in Somerville for supplying a small section of Somerville which is now supplied from the northern high-service. This line includes 143 feet of 24-inch pipe, 57 feet of 16-inch pipe and 51 feet of 12-inch by-pass line, and a 6-inch x 3-inch Hersey detector meter was installed. The connecting line which is to be installed by the city of Somerville had not been laid at the close of the year. The total expenditures for the work amount to \$2,768.83.

MAINTENANCE.

RAINFALL AND YIELD OF WATERSHEDS.

The annual precipitation was below the average on all watersheds, being 37.26 inches on the Wachusett watershed as compared with an average of 44.91 inches for the past twenty-one years and a previous minimum of 37.83 inches in 1908; 41.51 inches on the Sudbury watershed as compared with an average of 44.60 inches for the past forty-three years, and 41.69 inches on the Cochituate watershed as compared with an average of 45.23 inches for the past fifty-five years.

The monthly precipitation was above the average on all the watersheds during March, May, June, August and October, but there was a deficiency during the other months. The rainfall in July was the lowest shown by our records for this month on all watersheds, and the rainfall on the Wachusett watershed in April was the same as in April, 1915, and lower than the April rainfall for any other year included in our records.

The monthly yield from the Wachusett watershed was below the average except during May, June and October. The average yield for the year was 834,000 gallons per day per square mile, which is 78.5 per cent. of the average for the past twenty-one years. The yield from the Sudbury watershed was 750,000 gallons per day per

square mile, which is 76.5 per cent. of the average for the past forty-three years and 84.1 per cent. of the average for the past twenty years during which water has been discharged into the Sudbury Reservoir from the Wachusett watershed. The yield from the Cochituate watershed was 786,000 gallons per day per square mile, which is 85.5 per cent. of the average for the past fifty-five years.

During the year the city of Worcester turned 1,417,200,000 gallons of water into the Wachusett watershed from the 9.35 square miles formerly in this watershed which it took for its water supply in 1911, and by agreement the City is entitled to compensation from the Commonwealth for 207,800,000 gallons of this water which was delivered between June 15 and December 15.

STORAGE RESERVOIRS.

The capacities of the storage reservoirs of the Metropolitan Water Works, the elevation of the water surfaces and the quantity of water stored in each reservoir at the beginning and at the end of the year are shown by the following table: —

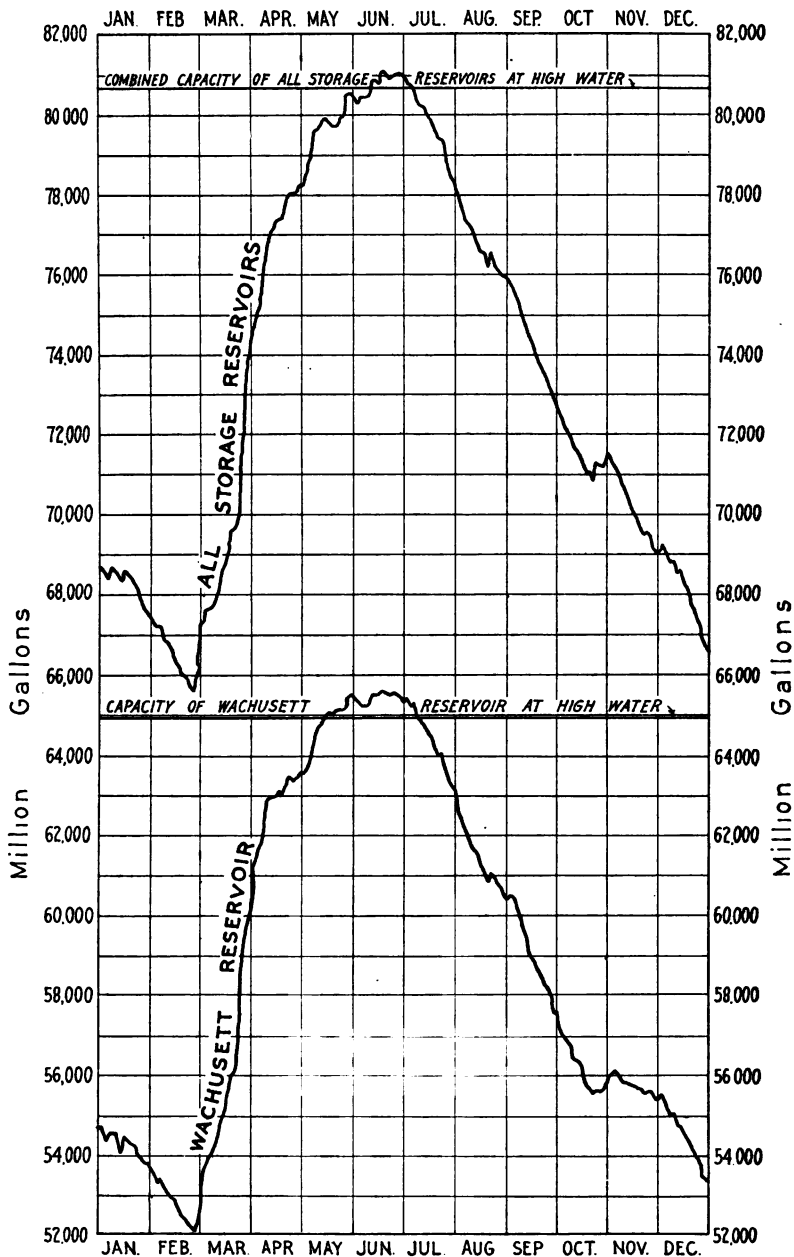
STORAGE RESERVOIRS.	Elevation ¹ of High Water.	Capacity (Gallons).	JAN. 1, 1917.		JAN. 1, 1918.	
			Elevation ¹ of Water Surface.	Amount stored (Gallons).	Elevation ¹ of Water Surface.	Amount stored (Gallons).
Cochituate watershed: —						
Lake Cochituate, ² . . .	144.36	2,097,100,000	143.23	1,830,100,000	141.91	1,524,600,000
Sudbury watershed: —						
Sudbury Reservoir, . . .	260.00	7,253,500,000	258.49	6,623,800,000	257.52	6,225,200,000
Framingham Reservoir No. 1, . . .	169.32	289,900,000 ³	167.70	216,100,000	167.71	216,500,000
Framingham Reservoir No. 2, . . .	177.87	529,900,000 ³	176.02	482,600,000	176.02	482,600,000
Framingham Reservoir No. 3, . . .	186.74	1,180,000,000 ³	183.53	942,300,000	183.25	920,300,000
Ashland Reservoir, . . .	225.21	1,416,400,000	224.28	1,365,200,000	223.59	1,327,900,000
Hopkinton Reservoir, . . .	305.00	1,520,900,000	304.07	1,462,700,000	303.30	1,415,100,000
Whitehall Reservoir, . . .	337.91	1,256,900,000	336.65	1,013,300,000	336.79	1,040,000,000
Farm Pond,	159.25	167,500,000	157.39	69,600,000	157.75	88,200,000
Wachusett watershed: —						
Wachusett Reservoir, . . .	395.00	64,968,000,000	387.11	54,679,600,000	385.94	53,225,600,000
Totals,	—	80,680,100,000	—	68,685,300,000	—	66,466,000,000

¹ Elevation in feet above Boston City Base.

² To top of flash-boards.

³ Excluding Dudley Pond which was abandoned April 3, 1916.

QUANTITY OF WATER STORED IN THE WACHUSETT RESERVOIR AND IN ALL THE STORAGE RESERVOIRS COMBINED DURING 1917



1. 1. 1.

2.

3.

4.

5.

6.

7.

8.

9. 1. 1.

10.

11. 1. 1.

12.

13. 1. 1.

14. 1. 1.

15. 1. 1.

16.

17. 1. 1.

18. 1. 1.

19. 1. 1.

20. 1. 1.

21. 1. 1.

22. 1. 1.

23. 1. 1.

24. 1. 1.

25. 1. 1.

26. 1. 1.

27. 1. 1.

28. 1. 1.

29. 1. 1.

30. 1. 1.

The diagram facing page 56 shows the quantity of water stored in the Wachusett Reservoir and the quantity stored in all the storage reservoirs combined during the year.

Wachusett Reservoir. — At the beginning of the year the Wachusett Reservoir contained 54,679,600,000 gallons of water and the surface of the water was at elevation 387.11, approximately 8 feet below high-water line. It subsided gradually and was at elevation 384.97 on February 23. It then rose rapidly with the spring rains and thaws and was at elevation 393.46 on April 11. The reservoir continued to fill slowly and the water reached elevation 395 on May 13 and remained above this elevation until July 9, and between May 28 and June 20, 1,473,900,000 gallons of water was wasted from the reservoir. The maximum rate at which water was wasted was 480,400,000 gallons per day on June 17 and 18. The highest stage reached by the water was elevation 395.55 on June 17. The reservoir then contained 65,710,900,000 gallons of water from which a steady draft for water supply was maintained until the end of the year, with the exception that no water was drawn between October 27 and November 6, in order to permit the Westborough State Hospital to extend its 12-inch suction pipe up the open channel of the Wachusett Aqueduct to the terminal chamber and to allow the contractor for the Wachusett-Sudbury transmission line to set the poles along the open channel. At the end of the year the reservoir contained 53,225,600,000 gallons of water and the surface of the water was at elevation 385.94.

During the year 1,298,600,000 gallons of water was discharged from the reservoir through the pool below the dam and through the pipe line to the Lancaster Mills, in accordance with the provisions of section 4 of chapter 488 of the Acts of the year 1895, which requires that not less than 12,000,000 gallons, and such further quantity, not exceeding 12,000,000 gallons, as the owner of the mills shall deem necessary, shall be allowed to flow from the reservoir during each week.

The emergency pumping station of the city of Worcester, located on the shore of the reservoir at South Bay in Boylston, was not operated by the city during the year. The Mayor and Water Commissioner of the city have agreed to remove all of the station and equipment, except the foundations and intake pipe, before the station is again submerged in the spring, but nothing had been done at the close of the year.

Miscellaneous débris brought into the reservoir during the high water flow in the spring was collected from the shores and disposed of at a cost of \$73.46.

The brook which enters the reservoir at the westerly side of Hastings cove, in Boylston, was straightened, graded and paved on the bottom and sides for a length of 395 feet at a cost of \$454.27.

At South Bay, in Boylston, the shore of the reservoir was paved for a distance of 102 feet and a width of 10 feet, and a wooden guard rail was constructed along the highway at the top of the slope. This work cost \$230, and was necessary to prevent the undermining of the highway by the action of the waves on the unprotected slope.

Brush and weeds have been mowed, raked into piles and burned along the sides of the highways adjoining the water works lands, along the brooks flowing directly into the reservoir and along the margin of the reservoir, from a strip of water works land 100 feet in width extending for a distance of $3\frac{1}{2}$ miles along the highways bordering the reservoir, and at the North and South dikes. This work extended over a distance of $58\frac{1}{4}$ miles and cost \$4,013.

Wheelock wire fences were constructed along the boundary of the water works land for a distance of 1,634 feet at the John Navaroli and Parker Banning lands in West Boylston at a cost of about 13 cents per linear foot, and an equivalent length of party fence was constructed by these adjoining owners.

The Wachusett Dam and gate chambers are in good repair. A joint leak in the 24-inch pipe line leading to the Lancaster Mills canal, which had been developing for some time and caused considerable settlement in the lawn below the dam, was repaired in June at a cost of \$563.26. To make these repairs it was necessary to excavate and tight sheet a trench about 20 feet long and 18 feet deep.

The nine water works tenements and the buildings at the Clinton and Oakdale storage yards have been repaired where necessary. On February 3 the one and a half story wooden dwelling formerly owned by Charles H. Baldwin at Sterling Junction was entirely destroyed by fire. The cellar has since been filled in, fruit trees cut down and grounds graded. On June 24 the one and a half story wooden dwelling in Boylston, occupied by patrolman Charles S. Knight and known as the Tucker house, was entirely destroyed

by fire. The cellar has been filled in, the trees which were injured by the fire cut down and the grounds graded. The barn at this place was not damaged at all by the fire and has been left for the use of the labor forces.

The old two story brick house, known as the Brelin house on Prescott Street, West Boylston, was razed in the fall and the cellar filled in and grounds graded. This house was last occupied in September, 1916.

Shortly after the loss of the Tucker house 15.81 acres of the Everett Kendall farm on Main Street, Boylston, with the buildings thereon, were purchased for the protection of the water supply. The house is now occupied by patrolman Knight, who uses the small barn, but the large wooden barn has been razed at a cost of \$354 and all the good lumber has been preserved for future use.

Seven acres of water works land easterly of Beaman Street, West Boylston, was leased to the Worcester County Commissioners for agricultural purposes in connection with the Worcester County Training School for boys.

Standing grass was sold from about 370 acres of water works land bordering on the reservoir and its tributary streams. The total receipts from the sale of this grass amount to \$1,083.75.

A Ford automobile, fitted with light truck body, was purchased in July for the use of the general foreman on work about the reservoir.

Sudbury Reservoir. — The water in the Sudbury Reservoir was at elevation 258.49, approximately one-half foot below the crest of the overflow, at the beginning of the year, and was kept at about this elevation until the flash-boards were put in place April 9. The water was then maintained between elevation 259 and 260 until the flash-boards were removed, November 15. Early in November the water was drawn down to elevation 257 to facilitate the erection of the poles for the Wachusett-Sudbury transmission line by the contractor for this work.

The usual attention has been given to the care of the reservoir lands and structures. The shores of the reservoir were cleaned and the débris which had collected in coves was removed. Loam and a mixture of chemical fertilizer and salt were put on the land slope of the dam embankment in the spring and some loam was prepared for future use.

The sprouts and brush were mowed in the lanes along the land lines through the woods for a distance of about 8 miles at a cost of \$78.00. Fifteen chestnut poles 25 feet in length for use on the works were cut, peeled and housed. Walks and drives were repaired, iron doors, grilles, manhole covers, bridge rails, flash-board standards, life preservers, signs, guards and agricultural implements were repaired and painted.

The Cratty house, in Fayville, was repaired by putting in a new hard pine floor and metal ceiling and by painting the woodwork and the new ceiling in the kitchen. The west side of the main house, where the clapboards were cracked and loose, was covered with roofing paper and shingled over the clapboards to keep the house warm.

Seventeen standard land bounds and one copper bolt were set to define the boundaries of land acquired from Frederick R. S. Mildon in 1916 and from Carl R. Lindstrom in 1917. Both of these parcels are located in Southborough. The Carl R. Lindstrom land, which was acquired this year, has an area of 2.36 acres.

Framingham Reservoir No. 3. — All of the water delivered through the Sudbury Aqueduct for the supply of the Metropolitan Water District was drawn from Framingham Reservoir No. 3, which was replenished with water from the Sudbury Reservoir, as required. During the winter the water was kept below the crest of the overflow, between elevations 183 and 185, and during the warm weather the water was kept above the crest, between elevations 185 and 186. Water was wasted from the reservoir into Framingham Reservoir No. 1 over the flash-boards on one day in June, and through the waste-gates at times in May and June. The gate-house and dam received the usual care. Fertilizer was spread over the embankments and brush was mowed in the lanes through the woods and along the boundary of the reservoir lands for a distance of $2\frac{1}{2}$ miles.

Framingham Reservoirs Nos. 1 and 2, Ashland, Hopkinton and Whitehall Reservoirs. — No water was drawn from these reservoirs for supplying the Metropolitan Water District during the year and they were kept substantially full, and, with the exception of Whitehall Reservoir, with flash-boards on the overflows when they were free from ice. In January and February the water in Framingham Reservoir No. 1 was drawn down about 4 feet to facilitate the work of installing a new water supply at the Bullard place, and during

the freshet season the water in Ashland and Hopkinton reservoirs was drawn down about one foot so that the flow in the Sudbury River could be controlled properly.

A discharge of not less than 1,500,000 gallons of water per day was maintained throughout the year from Framingham Reservoir No. 1 into the Sudbury River, as required by the provisions of chapter 177 of the Acts of the year 1872. Water was also discharged in larger quantities from time to time, as required to dispose of a portion of the yield of the watershed above Dam No. 1 which could not be stored in the reservoirs.

The usual attention was given to the dams, gate-houses and structures at these reservoirs. Fertilizer was spread on the reservoir embankments. The riprap slopes and the grounds at all dams and the ironwork and stop-planks at the gate-houses have been kept in good condition.

Early in the year a new water supply was installed at the water works premises known as the Bullard place, located on Salem End Road at Framingham Reservoir No. 1 and occupied by one of the foremen. It consisted of a Vaile-Kimes double-acting duplex pump with a capacity of 12 gallons per minute, a 30-inch diameter x 10 feet long steel pressure tank and a $\frac{3}{4}$ -horse power electric motor which operates the pump automatically with the variation of pressure in the tank. The apparatus is located in the house cellar. The pump is supplied with water from the 48-inch main located about 180 feet south of the house through a 2-inch cement-lined iron suction pipe, and a 1 $\frac{1}{4}$ -inch cement-lined iron supply pipe 130 feet in length extends from the pressure tank to the barn. An ample supply of water at a pressure of 50 pounds per square inch is now available at all times at the house and barn for fire protection or other purposes. The charge for electricity used to operate the pump has never exceeded the Company's minimum charge of 75 cents per month.

Brush has been mowed and burned for a total length of 21.6 miles along the waste channels and in the lanes through the woods, along the boundary lines of the water works lands at these reservoirs, and $\frac{3}{4}$ of a mile of new lanes have been cut at Hopkinton Reservoir.

Two bounds were set to mark the boundary of the water works lands recently acquired from E. E. Goodale at Whitehall Reservoir.

At Ashland Reservoir the gate-keeper's house was repaired by putting in a new platform and steps at the rear entrance. Late in the fall work was begun on the new barn, about 30 feet square, to replace the old barn which is no longer suitable for use. At the end of the year the cellar had been excavated, the foundation wall was built and work had been begun on the superstructure. This work is being done by the water works employees when not required elsewhere.

During the year one new cottage was built at Whitehall Reservoir, one was removed and one was torn down, so that there are now 64 cottages, or one less than last year, located on the shores of this reservoir. There were 8 motor boats, 84 sail boats and 25 canoes in use on the reservoir during the summer, a total of 117, or 8 less than in 1916.

Farm Pond. — Although Farm Pond is not used as a source of supply for the Metropolitan Water District the water therein has been kept within about $1\frac{1}{2}$ feet of the high-water line throughout the year by supplying it with water from Framingham Reservoirs Nos. 1 and 2 in January to accommodate the town of Framingham, which obtains a portion of its water supply from the filter-gallery located on the easterly shore of the pond. No water was wasted from the pond during the year. Under the rights reserved by legislation the town of Framingham pumped 207,800,000 gallons of water from the filter-gallery and the Boston & Albany and New York, New Haven & Hartford railroad companies took approximately 185,000,000 gallons directly from the pond for their use during the year.

Lake Cochituate. — At the beginning of the year the water in Lake Cochituate was at elevation 143.23, approximately one foot below high-water line. Water was drawn from the lake through the Cochituate Aqueduct for water supply in August and September, and was wasted at the outlet dam at times during every month in the year.

The buildings and grounds at the foreman's headquarters have received the usual attention and some repairs have been made at the house and wagon shed, and both of these buildings were given a coat of paint.

A gasoline-driven pump with a capacity of 6 gallons per minute, and a vertical steel pressure tank 36 inches in diameter x 6 feet in

height was purchased of the Goulds Manufacturing Company in September and was installed in the barn cellar to improve the water supply for the house and other buildings.

Brush was mowed in the lanes through the woods along the boundaries of the water works lands and the débris which had collected in the coves along the margins of the lake was removed.

In connection with the maintenance of the surface water drain from Cochituate Village the grass and brush were mowed for a width of 10 feet on both sides of the open channel and sediment was removed from the catch basins and from the sand catcher on Bannister's Brook.

During the year 36 cottages were built by adjoining property owners and two cottages were burned. There are now 124 cottages, 12 garages and one stable on the adjoining lands.

AQUEDUCTS.

Wachusett Aqueduct. — Water was discharged through the Wachusett Aqueduct from the Wachusett Reservoir on 302 days in 1917. The total time that the aqueduct was in use is equivalent to 118 days, 20 hours and 44 minutes. The total quantity of water discharged was 32,893,900,000 gallons, equivalent to an average of 90,120,000 gallons per day for the entire year. The Westborough State Hospital pumped 57,387,000 gallons of water, equivalent to an average consumption of 157,000 gallons per day, from the open channel just beyond the lower end of the masonry aqueduct. The 12-inch iron suction pipe through which the water is pumped was extended about 750 feet to the terminal chamber of the masonry aqueduct. By this arrangement the hospital is assured of water direct from the Wachusett Reservoir at all times. Since November 6, when this extension was completed, we have had the entire care and made all adjustments of the Venturi meter and recording apparatus which measures the water pumped.

While the water in the upper portion of the open channel was drawn off for the extension of the suction pipe the stone paving at the terminal chamber was extended for a distance of 25 feet. Heavy field stones were used for this work to prevent further erosion of the bottom and slopes by the action of the water as it enters the channel from the terminal chamber, and the water-grass, weeds and sediment were cleaned from the bottom and sides of the channel

for the entire distance of 4,670 feet above the upper dam. The cost of this work was \$209.26.

A driveway was constructed from Cedar Street, in Marlborough, crossing the New York, New Haven & Hartford Railroad to the terminal chamber. The roadway is 10 feet wide and was built with stones from an old wall, which were covered with bank sand and gravel from a spoil bank on the aqueduct lands. The edges of the driveway were graded with loam and seeded. A Wheelock wire fence was built on the property line on one side and 55 white spruce trees were set out in a row on the other side of the driveway for a length of 700 feet. The cost of the work, including a small retaining wall and culvert, the fencing and the grading was \$1,114.88.

A Wheelock wire fence 584 feet in length was erected on the property line between the parcel of land acquired last year, located near the terminal chamber and adjoining land of James B. Johnson.

The iron railings and fences have been painted with Smith's Durable Metal Coating at the lower dam, at 8 highways along the aqueduct and at the Assabet Bridge, also the manhole covers and ladders at all manholes and the ironwork at the gaging manhole.

About $6\frac{1}{2}$ acres of aqueduct embankment was harrowed, fertilized and seeded at a cost of \$136 per acre. This work extended over a distance of 5,800 feet and 10 tons of commercial fertilizer, $\frac{1}{2}$ ton of coarse salt and 6 bushels of grass seed were used in the work.

Brush, grass and weeds have been mowed and disposed of for a distance of 10 miles along the aqueduct at a cost of \$98 per mile.

Sudbury Aqueduct. — During the year the Sudbury Aqueduct was in service continuously for conveying water from Framingham Reservoir No. 3 to the Chestnut Hill distributing reservoir, with the exception of $9\frac{1}{2}$ hours on January 11, when the flow was stopped in order to convey water from Framingham Reservoirs Nos. 1 and 2 through the supply aqueduct to Farm Pond. The total quantity of water discharged through the aqueduct to Chestnut Hill Reservoir was 20,276,800,000 gallons, equivalent to an average of 55,553,000 gallons per day for the entire year, which is 5,193,000 gallons per day more than in 1916.

The iron floor and gate standards in the gate-house at Farm Pond were given one coat of paint.

The shed near the office at Framingham was made into a garage

about 33½ x 20 feet in dimension, by an addition extending 18 feet in the rear. A concrete floor was constructed and an Akron pipe was laid to a dry cesspool to take care of the wash water. The building was wired for electric lights and the surrounding grounds were graded. The cost of the garage, which will house three cars, with room for a bench and another car when making repairs, was \$410. The exterior of the garage and of the office was given one coat of paint.

The old stop-planks at the waste-weirs, which had been in position for a long time and had been set in cement mortar to prevent leakage, were taken out, and as they were found to be generally in poor condition new stop-planks, 24 in number, were made for the four waste-weirs.

About 29,000 pounds of mixed chemical fertilizer and salt were spread on the aqueduct embankments at places where needed to keep the land in good condition. The culverts were kept free from snow and ice. Brush, grass and weeds were mowed where the aqueduct land is not cared for by the adjoining owners. The city of Newton Sewer Department laid a line of 12-inch Akron pipe in Portland cement mortar in the culvert under the aqueduct at Pleasant Street, Newton Center.

Weston Aqueduct. — Water was supplied from the Sudbury Reservoir to the Weston Reservoir through the Weston Aqueduct on 304 days during the year. The total time that this portion of the aqueduct was in service is equivalent to 185 days, 19 hours and 14 minutes, and the total quantity of water discharged was 19,008,800,000 gallons, equivalent to an average of 52,079,000 gallons per day for the entire year, which is 620,000 gallons per day less than last year. As the aqueduct is now operated in connection with the Sudbury power station it has not been in service on Sundays and holidays, and the total flow for the week has been discharged between 7 A.M. and 11 P.M. on the other days.

The interior and exterior ironwork at the head-house, the man-hole covers along the aqueduct, both barns at the White place in Nobscot and the interior and exterior woodwork at the head-house were given one coat of paint. The main portion of the house at the White place was shingled.

Brush and sprouts growing from trees previously cut on the aqueduct land and in the lanes through the woods along the bound-

ary of the water works land on the southerly side of the aqueduct, at the White place and for 3,400 feet east of Water Street, Nobscot, where there is a large area of land, were mowed.

The culverts were kept free from snow and ice and 21,700 pounds of mixed chemical fertilizer and salt were spread on the large embankment between Edgell Street, Framingham, and the old Connecticut Path, Wayland, and at a few other places.

A Wheelock wire fence 900 feet long was erected along the aqueduct to replace an old wire fence that had entirely rusted away in some places. This fence was erected in most part on the existing posts but it was necessary to set 27 new posts. The iron fence and all of the interior ironwork at the terminal chamber were painted with black varnish and the driveway in front of the terminal chamber was surfaced with fine broken stone.

Cochituate Aqueduct. — Water was discharged through the Cochituate Aqueduct from Lake Cochituate to the Chestnut Hill distributing reservoir on 29 days during the year. The total time that the aqueduct was in use is equivalent to 27 days, 8 hours and 20 minutes, and the total quantity of water discharged was 125,400,000 gallons.

The aqueduct embankments were dressed with mixed chemical fertilizer where necessary to keep them in satisfactory condition. Six thousand pounds of fertilizer was used in the work. The culverts along the line have been kept free from ice, and brush, grass and weeds were mowed.

The Newton & Watertown Gas Light Company laid a 2-inch wrought-iron pipe across the aqueduct from Carver Road to the Atlas Film Corporation building, in Newton Highlands, for a distance of 320 feet.

The town of Wellesley laid a line of 10-inch cast-iron pipe from its main sewer in Washington Street, across the aqueduct to Park Street, a distance of 48 feet, a line of 8-inch iron pipe 60 feet in length on Worcester Street across the aqueduct to the manhole 12 feet easterly from the center of the aqueduct, and from this point a line of 10-inch iron pipe for a distance of 24 feet. All of these lines were laid with lead joints, under our supervision, to ensure water-tight work.

Between Blossom Street and Wellesley Hills Square 17 house connections were made from the main sewer in Central and Wash-

ington streets. These house connections were made with 5-inch cast-iron pipe with lead joints, under our supervision, as most of them cross the aqueduct.

SANITARY INSPECTION OF WATERSHEDS.

The usual sanitary inspection of the watersheds was made during the year for the purpose of preventing the pollution of the water supply. A summary of the work is given in the tables on pages 68 and 69.

Ice cutting operations were inspected at the several ponds and reservoirs during the winter and special watchmen were employed from May to September, inclusive, to prevent bathing and unauthorized boating and fishing in the reservoirs.

Wachusett Watershed.

On the Wachusett watershed 17 dwellings were built during the year, 5 buildings were destroyed by fire and 1 was removed. As a result of these changes there has been an increase of 11 premises on the watershed during the year, making the total premises at the close of the year 1,731.

The most notable changes on the Wachusett watershed during the year are the extensive additions to the Jefferson Manufacturing Company's mills at Jeffersonville and Eagleville, the destruction by fire of the Warren tannery at Holden on June 19 and of the Town Hall in West Boylston early Christmas morning, the sale by the farmers of their flocks and herds, and the reduction of agricultural and increase of industrial activities.

Summary of Sanitary Inspections on the Wachusett Watershed in 1917.

DISTRICT.	Number of Premises in- spected.	CLASSIFICATION OF CASES INSPECTED.										CONDITION AT END OF YEAR.		WATER SUPPLY.					
		Cesspools dug before 1917.	Cesspools dug during 1917.	Direct Privy Drain- age.	Indirect Privy Drain- age.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.	Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.	Premises having Pub- lic Supply.	Premises having Pri- vate Supply.	Premises on which no Water is used.	
							Satisfactory.	Unsatisfactory.											Satisfactory.	Unsatisfactory.
French Brook, . . .	70	40	3	-	-	-	21	-	18	-	4	2	-	70	-	7	57	6	
Muddy Brook, . . .	42	16	3	-	-	-	19	-	17	-	2	1	1	42	-	-	39	3	
Gates Brook, . . .	212	150	5	-	-	-	44	2	53	1	8	3	-	210	2	4	197	11	
Malden Brook, . . .	34	15	-	-	-	-	17	-	20	-	1	1	-	34	-	-	32	2	
Chaffin Brook, . . .	213	128	4	-	-	-	64	6	86	-	1	5	-	206	7	88	115	10	
Anebumakit Brook, . .	217	160	-	-	2	10	24	2	45	2	10	8	1	201	16	181	18	18	
Muschopauge, . . .	92	36	-	-	-	-	37	-	41	-	1	14	5	91	1	7	66	19	
South Wachusett Brook,	87	39	-	-	-	-	37	-	41	1	8	3	-	86	1	-	76	11	
Trout Brook, . . .	34	5	-	-	-	-	23	-	20	-	1	3	2	33	1	-	29	5	
East Wachusett Brook, .	216	85	2	-	-	-	87	3	93	-	24	15	1	213	3	-	177	39	
Stillwater River, . . .	144	69	1	-	-	-	48	2	64	3	12	11	1	140	4	-	121	23	
Wachusacum, . . .	334 ²	79	2	-	-	-	71	2	58	1	4	15	94	331	3	-	315	19	
French Hill, . . .	35	26	-	-	-	-	6	-	14	-	2	1	-	35	-	-	32	3	
Totals, . . .	1,730	848 ²	20 ²	-	2	10	498 ²	17	570	8	5	97	72	98	1,692	38	287	1,274	169

¹ On some premises there are two or more cases.

² Including 160 summer dwellings at the Wachusacum Lakes.

³ Summer dwellings not classified.

Summary of Sanitary Inspections on the Sudbury and Cochrane Watersheds in 1917.

DISTRICT.	Number of Premises in- spected. ¹	CLASSIFICATION OF CASES INSPECTED.											CONDITION AT END OF YEAR.				
		Sewer Connections.	Cesspools dug before 1917.	Cesspools dug during 1917.	Direct Privy Drain- age.	Indirect Privy Drain- age.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.						
SUDBURY WATERSHED.																	
Farm Pond,	328	316	6	-	-	-	-	-	1	8	-	-	-	4	-	328	-
Framingham Reservoir No. 3,	96	66	-	-	-	-	-	23	1	44	1	-	6	-	94	2	-
Stony Brook,	301	260	1	-	-	-	-	23	2	33	4	-	10	6	2	296	5
Angie Brook,	2,029	1,648	266	-	-	-	-	84	2	196	1	-	13	16	1,830	2,027	2
Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook,	336	-	253	2	-	-	-	60	1	98	1	-	22	2	-	335	1
Eastern Sudbury,	232	-	210	2	-	-	-	9	-	26	3	-	-	4	-	232	-
Indian Brook,	403	-	227	-	-	-	-	103	6	63	3	-	45	7	-	394	9
Western Sudbury,	183	-	110	-	-	-	-	47	6	53	2	1	12	9	-	176	7
Whitehall Reservoir,	177	-	63	-	-	-	-	82	1	36	1	-	28	2	-	177	-
Cedar Swamp,	792	546	172	1	-	2	-	41	5	105	-	-	25	13	-	787	5
Totals,	4,877	2,510	1,643	7	-	2	-	472	24	662	13	1	161	63	1,832	4,846	31
COCHITUATE WATERSHED.																	
Snake Brook,	243	-	185	23	-	1	-	15	1	27	1	-	30	-	-	242	1
Pegan Brook,	1,067	778	249	2	-	-	-	31	-	67	-	1	21	13	1,021	1,067	-
Course Brook,	139	2	107	1	-	-	-	16	-	33	-	-	7	1	-	139	-
Beaver Dam Brook,	1,729	1,341	267	11	-	-	1	53	2	143	2	-	21	16	1	1,724	5
Totals,	3,198 ²	2,121	808	37	-	1	1	115	3	270	3	1	79	30	1,022	3,192	6

¹ On some premises there are two or more cases.² Including 210 summer dwellings.

Sudbury Watershed.

On the Sudbury watershed there were 4,874 premises at the beginning of the year and 4,877 at the end of the year, an increase of 3 premises during the year; resulting from the construction of 11 buildings and the destruction by fire or removal of 8 buildings.

There has been some increase in industrial activity in Ashland, Hopkinton and Marlborough during the year.

On October 12 two factories, a rooming house and a hotel were completely destroyed by fire in Westborough.

A mobilization camp for the 6th Regiment, M. V. M., was located in June on Dudley Road, near Farm Pond, in Framingham. Surface drainage from this area was diverted by an intercepting ditch from the pond some years ago by the city of Boston, but as the camp was located quite near the pond and Sudbury Aqueduct precautions were taken to see that there was no pollution of the Metropolitan water supply. The town of Framingham has maintained a supervised public swimming pool for the past three years in that part of the pond located south of the aqueduct and known locally as Little Farm Pond. This pool was ideally located for the use of the soldiers, over 16,000 baths being taken, so that there was no temptation for them to go elsewhere.

The new low-level sewer which is to serve the northern and eastern sections of the city of Marlborough has been completed but as yet no houses on the Sudbury watershed have been connected. The authorities have not urged the owners to make these connections this fall because of the scarcity of pipe.

Cochituate Watershed.

On the Cochituate watershed there were 3,144 premises at the beginning of the year and 3,198 at the end of the year, an increase of 54, which results from the construction of 57 buildings and the destruction by fire or removal of 3 buildings.

PROTECTION OF THE WATER SUPPLY.

Filtration and Chlorination.

On the Wachusett watershed the surface water from 525 acres in the village of Sterling has been filtered at the Sterling filter-beds. The sewage from the Worcester County Training School has been

purified at the filter-beds on Beaman Street in West Boylston. This institution now accommodates about 87 boys and teachers. The sewage from the five small cottages at Sterling Junction was filtered at the Gates Terrace filter-beds from April 11 to November 3, while the cottages were occupied. The cost of maintaining all of these filters was \$713.57.

On the Sudbury watershed the surface water from an area of 2 square miles in Marlborough has been filtered at the Marlborough Brook filter-beds before entering the Sudbury Reservoir, with the exception of 15,200,000 gallons on February 26 and 27 which the filters could not take care of, and as it overflowed at the waste-ways it was treated with calcium hypochlorite. No diluted sewage from the Marlborough main sewer was received at the combined storage reservoir and filter-bed on Farm Road, but ground water from the sewer underdrain was filtered at this bed at times during the spring and fall. The drainage from the Southborough swimming pool was filtered at the beds near Boston Road and the pool was cleaned once during the season. The surface water from Cherry Street brook at Fayville was treated with calcium hypochlorite weekly in wet weather and when necessary during dry weather from April to December. The cost of the filtration and chlorination work on the Sudbury watershed was \$2,882.83.

On the Cochituate watershed the surface water from an area of about one square mile of the thickly settled portion of the town of Natick was pumped at the Pegan filter station and filtered before it entered Lake Cochituate, with the exception of the overflow from the intercepting reservoir on February 26 and 27 and from March 11 to 18 and on May 6, during which time there was a total overflow of 15,200,000 gallons which was treated with calcium hypochlorite.

The pumping station was operated on 234 days during the year and 305,935,000 gallons, equivalent to an average of 838,000 gallons per day for the entire year was pumped to the filters. The cost of operating and maintaining the pumping station and filters was \$4,415.50 which is equivalent to a cost of \$14.43 per million gallons pumped.

The amount of water pumped and the cost per million gallons was increased this year as in previous years by waste from the Natick Box Company's factory which flowed through the inter-

cepting ditch into the intercepting reservoir, and the removal of the paper pulp deposited in the settling reservoir and on the filter-beds has been a source of considerable expense which, as in former years, will be paid by the Natick Box Company.

Improvement of Swamps and Brooks.

The ditches maintained in the swamps on the watersheds for improving the quality of the water were cleaned and the weeds and brush were mowed for a width of 10 to 20 feet on both sides where necessary. The total length of these ditches is 36.67 miles, of which 27.73 miles have been cared for by the Wachusett Department at a cost of \$932.60 for the usual cleaning and mowing. An expenditure of \$1,110.45 was made for repairing slopes and paving for a distance of 9,120 feet and for replacing the board bottoms and slope footings for a distance of 2,040 feet. The cost of the usual cleaning and mowing along the 8.94 miles of ditches which are cared for by the Sudbury Department was \$400, and an expenditure of \$398 was made for repairing the board bottoms and sills for a length of 1,371 feet, slope footings for a length of 4,165 feet and paving for a length of 1,871 feet. This work covered short distances in all of the ditches. A portion of the Mowry Brook drainage ditch was rebuilt on account of the relocation of Boston Road in Marlborough by the Massachusetts Highway Commission. The work on the ditch was done by the department forces at a cost of \$51.37, which was repaid by the Highway Commission.

An area of about $4\frac{1}{2}$ acres in Little Crane Swamp, Northborough, where the growth of swamp maple, elm and chestnut was damaged by fire in 1911 and was badly infested with the gypsy moth, was cleared at a cost of \$358.90. About 80 cords of wood, valued at \$266, and 9 chestnut poles 40 feet in length, which were used in the transmission line, valued at \$65, were obtained from this work.

Wheelock wire fencing has been erected on the property line between the water works land and land of Garad Busby in Northborough for a distance of 1,050 feet, at a cost of \$142.50, and an equivalent length of party fence was erected by Mr. Busby.

The lanes cut in previous years along the boundary line of Cedar Swamp in the Sudbury Department were mowed for a length of 18,600 feet and new lines were cut for a length of 14,000 feet.

The work of improving Gates Brook in the Wachusett watershed,

at the district known as "The Settlement" in West Boylston, which was begun in 1915 and continued in 1916, was resumed on July 23 and was suspended for the season on September 20 on account of the scarcity and high cost of labor and of the State highway construction in the vicinity, which increased the cost of transporting the materials. During 1917 one concrete culvert 40 feet long and 440 feet of open channel of the standard swamp drainage board-bottom type were constructed. About half of the work is now finished. The expenditures for the work during 1917 were \$1,171.71, and the total to date \$4,773.18.

The Maple Street Brook in Marlborough in the Sudbury watershed was kept free from débris.

The condition of Beaver Dam Brook in the Cochituate watershed was considerably improved in appearance and capacity during the month of October for a distance of 12,700 feet above Mill Street, in Natick, where it enters Lake Cochituate, by removing sand bars and débris from the channel and by cutting the brush and weeds along the banks. The expenditure for this work amounted to \$690.

For the protection of the water supply on the Wachusett watershed 15.77 acres of land, located on Main Street in Boylston, has been acquired during the year.

CLINTON SEWAGE DISPOSAL WORKS.

Pumping Station.

Chapter 557 of the Acts of the year 1898 provides that works for the disposal of the sewage of the town of Clinton shall be maintained and operated by the Metropolitan Water Works until the sewage of said town shall have outgrown the normal capacity of the South Branch of the Nashua River to properly dispose thereof. In connection with the operation of works for this purpose the pumping station was operated daily and the quantity of sewage pumped to the filter-beds was equivalent to 1,050,000 gallons per day throughout the year, which is 175,000 gallons per day less than in 1916. This decrease in the quantity pumped was due to the small flow in the Nashua River, which reduced the leakage of ground water into the adjacent defective sections of the town sewers.

The Blake compound duplex pump and the boiler, which have been kept in reserve since the electrically-driven 12-inch DeLaval

centrifugal pump was installed in 1912, were overhauled and repaired for use in case of emergency.

With the exception of two days, when the steam pump was being operated on trials, all of the sewage was pumped with the centrifugal pump. The pumping statistics are as follows: —

Total pumpage (gallons),	383,148,000
Average pumpage (gallons per day),	1,050,000
Electric energy used (kilowatt hours),	119,455
Pumpage per kilowatt hour (gallons),	3,206
Average lift (feet),	49.6
Efficiency of pumping unit and transmission line (per cent.),	55.5
Coal used for burning sludge and heating (pounds),	71,390

Cost of pumping: —

Labor,	\$1,043 04
Electric energy at \$5.30 per thousand kilowatt hours,	633 11
Coal for burning sludge and heating,	198 88
Repairs and supplies,	176 13
Total for station,	\$2,051 16

Cost per million gallons,	\$5.35
Cost per million foot gallons,	0.1079

Filters.

The filter-beds and settling basins were operated jointly daily throughout the year by first passing the sewage through one of five settling basins the effluent from which was applied to the 25 one-acre sand filter-beds in regular doses of about 60,000 gallons of sewage in 30 minutes, at intervals of about $1\frac{1}{2}$ days, equivalent to about 41,000 gallons per acre per day. The cost of maintaining the filters during 1917 was as follows: —

Labor,	\$5,034 66
Supplies and expenses,	265 34
Total,	\$5,300 00

Cost per million gallons filtered,	\$13 83
--	---------

The two wooden buildings and the woodwork on the carriers, manholes and settling basins have been repaired and painted and the concrete floors of the carriers have been repaired.

The character of the effluent, as shown in the following table, has been much less satisfactory than in previous years, and the operation of the beds has been difficult because the filtering material has now become clogged with organic matter to a depth of 6 or 8 inches. Plans have been made to inaugurate measures for the improvement of the condition of the filters during the coming summer.

[Parts per 100,000.]

	1915.	1916.	1917.		
			January to June.	July to December.	Whole Year.
Albuminoid ammonia, sewage,	1.4350	1.0255	.7170	1.0133	.8652
Albuminoid ammonia, effluent, . . . . .	.09347	.0983	.14675	.12985	.1383
Reduction, per cent.,	93.5	90	80	87	84
Oxygen consumed, sewage,	9.5333	7.70	7.27	7.97	7.62
Free ammonia, sewage,	3.7867	2.7850	3.0013	3.9400	3.4707
Free ammonia, effluent, . . . . .	.5924	1.0316	1.8184	1.7133	1.7658
Reduction, per cent.,	84	63	39	57	49
Nitrogen as nitrates, effluent, . . . . .	.7152	.3693	.2065	.1966	.20165
Iron, effluent, . . . . .	.30815	1.052	1.710	2.363	2.036
Average quantity of sewage filtered, gallons per day.	941,000	1,225,000	1,169,000	930,000	1,050,000

FORESTRY.

Wachusett Department.

An area of about 74 acres back of the Westerly portion of the North Dike at the Wachusett Reservoir was cleared of a growth of scrub oak and planted with white pine seedlings 4 years old from the North Dike nursery. They were spaced 12 feet apart in rows 12 feet apart. It is planned to interplant these white pines with red pines from the Oakdale nursery during 1918, making the completed plantings 6 feet x 6 feet.

As the main trunk lines of two divisions of the Boston & Maine Railroad pass parallel to and about 500 feet distant from this area, with only a highway 60 feet wide to prevent fires from spreading to the planted area, an additional fire guard 50 feet wide on the railroad side of the highway was cleared for a distance of 5,400 feet, and for 10 feet in width it was grubbed and plowed.

An area of $3\frac{1}{2}$ acres which was acquired in 1916, located near the

terminal chamber of the Wachusett Aqueduct, was cleared and planted with white pine seedlings 4 years old from the North Dike nursery.

Along the open channel portion of the Wachusett Aqueduct in Southborough and the marginal lands of the Wachusett Reservoir in Clinton, Boylston and West Boylston 103½ acres of water works land was planted with white pine seedlings 4 years old from the North Dike nursery and white spruce seedlings 5 years old from the Oakdale nursery. In this work 98,100 white pine and 1,300 white spruce seedlings were used. The cost of clearing the land was \$36.46 per acre and of planting the trees was \$15.04 per thousand.

In the fall 8,550 white pine seedlings 5 years old from the North Dike nursery were planted to fill in where trees from previous plantings had died, and about 700 white pine trees from 18 to 24 inches in height were set out on the sites of the three buildings which were removed from water works land between High Street and the Clinton sewerage filter-beds in Lancaster.

The necessary care has been given to the trees in the Oakdale and North Dike nurseries, which at the end of the year contained the following: —

Oakdale Nursery.

White pine seedlings, 3 years old, in transplant beds,	94,000
White pine seedlings, 2 years old, in transplant beds,	8,200
Scotch pine seedlings, 3 years old, in transplant beds,	41,400
Red pine seedlings, 3 years old, in transplant beds,	40,800
Red pine seedlings, 5 years old, in transplant beds,	120
Norway pine seedlings, 3 years old, in transplant beds,	200
Sequoia seedlings, 6 years old, in transplant beds,	100
White spruce seedlings, 6 years old, in transplant beds,	11,100
Tamarack seedlings, 2 years old, in transplant beds,	5,800
Maple seedlings, 1 year old, transplanted from field,	750
Arbor vitæ seedlings, 2 years old, in seed beds,	400
	<hr/>
	202,870

North Dike Nursery.

White pine seedlings, 5 years old, in transplant beds,	6,500
White pine seedlings, 3 years old, in transplant beds,	37,500
	<hr/>
	44,000

The sprouts and undergrowth which were interfering with the pines on about 69 acres of land planted during the last five years were cut and disposed of at a cost of about \$22 per acre.

About 350 acres of land along the main highways about the Wachusett Reservoir and at the dam, known to be infested with the gypsy moth, was sprayed with 8,500 pounds of arsenate of lead between June 2 and July 7, at a cost of \$1,726.42. This work was done with the power sprayer auto truck, which was thoroughly overhauled and equipped with a 40-horse power Waukesha motor early in the year before the beginning of the spraying season.

The work of scouting the marginal lands of the reservoir for gypsy moth egg clusters and painting them with creosote, begun in the fall of 1916, was continued through the winter; it was then suspended and was resumed in the late fall. At the close of the year about 2,500 acres of land had been covered and most of the land had been gone over a second time. About 245,000 egg clusters were found and painted at a cost of \$926.10.

During July and August many of the plantings on the marginal lands around the reservoir were inspected for the pine-tree weevil on two occasions. During the first inspection 2,540 leaders were cut and burned and 380 during the second inspection. The number of leaders attacked was much fewer than during previous years, due to the fact that as the trees become older the weevil gradually disappears. The cost of the work was \$81.27.

A thorough inspection of the white pine forests on the marginal lands of the Wachusett Reservoir was made during the year by experts from the Nursery Inspection Department of the Commonwealth, but no evidence of white pine blister rust was found.

It has been noticed that the brown-tail moth has entirely disappeared from the water works land in this department.

The total cost of protecting the trees and plantings from insects and disease during the year was \$2,736.40.

The usual fire patrol service was maintained during the spring and fall seasons. On April 16 the only fire of any consequence occurred. Seven acres of land on the easterly side of Beaman Street, West Boylston, was burned over and about 8,000 white pines from 3 to 10 feet in height were destroyed.

The brush, grass and weeds on $1\frac{3}{4}$ miles of the marginal fire guard, which is 40 feet wide, and on $31\frac{3}{4}$ miles of forest roads from 15 to 45 feet wide, were mowed and burned at a cost of \$1,150.84.

At the close of the year the water works land in the Wachusett watershed may be classified as follows: —

Forest lands acquired and not since improved (acres),	1,365
Forest lands acquired and since improved (acres),	324
Land which has been planted with trees and not cleared (acres),	399
Land which has been planted with trees and since cleared (acres),	1,098
Land to be planted with trees (acres),	584
Open land which will probably not be planted (acres),	811
Marginal strip along shore of the reservoir (acres),	209
Total,	4,790

The total expenditures for forestry during the year in the Wachusett Department were \$13,693.31.

Sudbury Department.

At the Sudbury Reservoir about 26 acres of land on Pine Hill on the northerly side of the reservoir and about 2 acres east of the junction of the Framingham, Marlborough and Acre Bridge roads was cleared of small trees and brush in preparation for transplanting pine seedlings. All of the large trees were cut into cord wood and the limbs and brush were burned. The cost of the work was \$22 per acre.

The lower limbs of the pine trees on the south side of the reservoir and west of the dam were cut off and grass and brush growing between the pines and the roads were burned to protect the pines from fire.

In May and June 49,300 white pines 3 years old, 43,700 Scotch pines 3 years old, 44,050 red pines 3 years old and 43,500 white spruces 4 years old were field planted from the nursery. Fifty thousand white pine seedlings 2 years old were received from the nursery of the State Forester's department at Barnstable and set out in the new water works nursery on the Ball land for use in field planting during the coming season.

Quite a number of field planted pines about 2½ feet in height were taken up and transplanted on adjacent land in connection with the work of clearing for the Wachusett-Sudbury transmission line.

Fire patrol service was maintained at times when the conditions were favorable for fires to spread rapidly, and where pine trees

have been planted along the highways the dried grass and brush were mowed, or burned if conditions were favorable, between the highway and the plantings.

Two fires occurred at the Sudbury Reservoir: one on April 24, which burned over two acres of planted land and destroyed 2,400 white pines about $2\frac{1}{2}$ feet in height; the other, on May 11, burned over $\frac{3}{4}$ of an acre of grass land and caused no damage.

The sprouts and brush along the Weston Aqueduct between Millwood Street and the entrance to Tunnel No. 3 in Framingham and at some other places where they were high enough to hinder the growth of the field planted pines were mowed.

Fifteen hundred white pines 3 years old from the nursery at the Sudbury Reservoir were set out west of Edgell Street, in Nobscot, and 1,500 were set out on the gravel slope between the aqueduct and the old Connecticut Path near Cochituate Road in Wayland.

The trees at the Sudbury and Framingham reservoirs, at Lake Cochituate and at the White place and siphon chamber No. 2 on the Weston Aqueduct were sprayed with arsenate of lead to protect them from the gypsy moth and other insects. A horse-drawn power sprayer was used for this work. It was in use about one month. Ten thousand pounds of arsenate of lead was used and the total cost of the work was \$1,900.84.

Some time was spent scouting for gypsy moth egg clusters and painting them with creosote. About 120,000 clusters were found and painted at a cost of \$500.

The plantings in the Sudbury Department were inspected for the pine-tree weevil and the leaders were cut and destroyed where the weevil was found. The cost of the work was about \$275.00.

The brown-tail moth caterpillars were destroyed within 50 feet of the highways at the Sudbury and Framingham reservoirs and where found in connection with spraying operations.

The total amount expended for forestry in the Sudbury Department during the year was \$7,596.44.

Pipe Lines and Reservoirs Department.

The gypsy and brown-tail moths and the elm-leaf beetles were destroyed on water works lands around the distribution reservoirs as in former years by spraying the foliage with arsenate of lead in June and July, by painting the gypsy moth egg clusters with creo-

sote and cutting and burning the webs of the brown-tail moth during the winter.

The spraying was done with a power sprayer drawn by two horses and an area of approximately 140 acres was covered. Five thousand, four hundred and thirty pounds of arsenate of lead in paste form was used, and was mixed in the proportion of 10 pounds of paste to 100 gallons of water.

Oyster scale, found on the shrubs at Chestnut Hill Reservoir, was destroyed by using Scalecide and Arlington oil.

The leaders were cut from some of the pine trees at the Weston Reservoir which were attacked by the pine-tree weevil.

The total expenditures for forestry in the Pipe Lines and Reservoirs Department was \$3,821.86.

HYDRO-ELECTRIC SERVICE.

The total quantity of electric energy delivered during the year from the two hydro-electric stations which are operated in connection with the Metropolitan Water Works, was 11,942,769 kilowatt hours.

The total value of this energy at the contract prices is \$67,961.93. The total expenses chargeable to both stations are \$35,530.24, leaving a profit from the operation of the stations of \$32,431.69, equivalent to \$2.715 per thousand kilowatt hours.

Wachusett Power Station.

The Wachusett power station was operated on 299 days during the year. The energy not used in connection with the operation of the Metropolitan Water Works was sold to the New England Power Company under an agreement made September 30, 1916, which provides that until the completion of the Wachusett-Sudbury transmission line the Company will take as much energy from the Wachusett power station as it can reasonably and properly use without wasting water at its own plants. Under this arrangement 99.1 per cent. of the total amount of water drawn from the reservoir into the Wachusett Aqueduct was used to develop electric energy. This is the largest portion of the total water drawn into the aqueduct that has been used for the development of electricity in any year since the station was put into regular service in 1911.

On August 21 an unusually severe electrical storm damaged one of the lightning arrester units and caused other minor damage to the plant, but temporary repairs were readily made and there was only a short interruption of the regular service during and immediately after the storm.

During the latter part of the year the electrical apparatus was carefully inspected and all meters were tested and accurately adjusted by engineers from the testing laboratory of the Edison Electric Illuminating Company of Boston.

The Wachusett power station statistics for the year 1917 are as follows: —

Total energy developed (kilowatt hours),	7,043,836
Energy used at power station (kilowatt hours),	11,862
	<hr/>
Available energy (kilowatt hours),	7,031,974

Water used (gallons),	32,595,100,000
Average head (feet),	95.9
Energy developed per million foot gallons (kilowatt hours),	2.25
Efficiency of station (per cent.),	71.71

Credits: —

Energy sold New England Power Company, 6,912,519 kilowatt hours at \$0.0053,	\$36,636 35	
Energy furnished Clinton sewerage pumping station, 119,455 kilowatt hours at \$0.0053,	633 11	
	<hr/>	\$37,269 46

Charges: —

Superintendence,	\$720 00	
Labor, operating station,	5,381 56	
Repairs and supplies for station,	1,262 42	
	<hr/>	\$7,363 98
Taxes,	3,025 00	
Administration, general supervision, interest and sinking fund,	6,560 00	
	<hr/>	16,948 98

Profit,	\$20,320 48
-------------------	-------------

Cost of available energy per thousand kilowatt hours,	\$2.410
---	---------

Sudbury Power Station.

As the Sudbury power station was put into service late in 1916 considerable miscellaneous work was necessary during 1917 to get all of the accessories in satisfactory condition. A Morse silent chain drive was substituted for the noisy herring-bone gears on the oil pump of the hydraulic governor equipment. Remote control devices were installed for opening the oil drain valves on the two 750 kilowatt transformers from points near the switchboard. Oil gage glasses were put on the generators and an air receiver 21 inches in diameter and 6 feet high was installed with hose and nozzle for blowing dust out of generator coils and other inaccessible places.

As the mechanism furnished by the Coffin Valve Company in 1916 for operating the sluice gates did not give the guaranteed results the Company this year installed larger electric motors, substituted some new gears and relined and rebabbitted the bearings on the gate stands and they now operate the gates in a satisfactory manner.

Water supply and toilet facilities were installed, and window and door screens were provided for use in warm weather.

A pipe line consisting of 434 feet of 2-inch iron pipe and 456 feet of 4-inch vitrified clay pipe with open joints was laid to connect the tight cesspool which receives the sewage from the power station with a filtering cesspool located in a gravel pit on the water works land well removed from the water supply. As often as the tight cesspool fills it is emptied into the filtering cesspool through the pipe line by means of a portable Swaby centrifugal pump with a capacity of 30 gallons per minute, operated by a 1½-horse power Brownwall air-cooled gasoline engine which was purchased for pumping out culverts on the aqueduct lines.

During a severe electric storm which passed over the station on August 21 several porcelain insulators were broken on the main circuit breaker and other minor damage was done by lightning.

The entire output, with the exception of a small amount of energy used for lighting the station and operating the electrically driven accessories, has been sold to the Edison Electric Illuminating Company of Boston under a contract dated December 21, 1914. The station is not regularly operated on Sundays or legal holidays.

All of the water discharged from the Sudbury Reservoir, with

the exception of 13,500,000 gallons, which was wasted at the overflow on February 27 and 28, was used for the development of electric energy.

The Sudbury power station statistics are as follows: —

Total energy developed (kilowatt hours),	4,928,900
Energy used at power station (kilowatt hours),	18,105

Available energy (kilowatt hours),	4,910,795
--	-----------

Framingham Reservoir No. 3 service: —

Water used (gallons),	19,671,600,000
Average head (feet),	66.00

Weston Aqueduct service: —

Water used (gallons),	19,008,800,000
Average head (feet),	39.10

Energy developed per million foot gallons (kilowatt hours), .	2.41
Efficiency of station (per cent.),	76.80

Credit: —

Energy sold Edison Electric Illuminating Company of Boston, 4,910,795 kilowatt hours at \$0.00625,	\$30,692 47
---	-------------

Charges: —

Superintendence,	\$1,190 00
Labor, operating station,	8,294 25
Repairs and supplies for station,	1,583 01

\$11,067 26

Taxes,	1,054 00
Administration, general supervision, interest and sinking fund,	6,460 00

18,581 26

Profit,	\$12,111 21
-------------------	-------------

Cost of available energy per thousand kilowatt hours,	\$3.784
---	---------

DISTRIBUTION PUMPING SERVICE.

The total quantity of water pumped at the five distribution pumping stations during the year was 23,608,020,000 gallons, which is 1,568,750,000 gallons or 7.12 per cent. more than the quantity pumped in 1916. The total quantity of water supplied to the Metro-

politan Water District in 1917 was 40,161,778,000 gallons or 3.19 per cent. more than in 1916, and of this quantity 58.14 per cent. was pumped for the southern high and low and the northern high and extra high-service districts, and 0.65 per cent. was repumped for the southern extra high-service district.

The total cost of operating all of the stations for the year 1917 was \$132,331.03, which is \$34,491.12 more than for 1916. This increase includes \$8,540.91 for labor, \$20,150.63 for fuel, \$5,141.32 for repairs, \$211.60 for oil and waste and \$446.66 for small supplies.

The increase for labor is due in part to the employment of five additional men on account of increased work at some of the stations, and so that no employee would be alone on a watch when the machinery was in motion, and in part to a general increase of ten per cent. in wages which has been effective since May 27. The other increases are due almost entirely to the increased cost of materials and supplies.

The amount of coal purchased from various parties for the pumping stations and the cost of the coal is as follows: —

DEALERS.	STATIONS (AMOUNT IN GROSS TONS).					Cost per Gross Ton in Bins. ⁴
	Chestnut Hill No. 1. ¹	Chestnut Hill No. 2. ²	Spot Pond. ³	Arlington. ³	Hyde Park. ³	
E. Russell Norton, bituminous,	967.28	-	-	-	-	\$4 51
E. Russell Norton, bituminous,	36.61	-	-	-	-	4 89
E. Russell Norton, bituminous,	-	1,278.75	-	-	-	4 36
Shaftsbury Coal & Coke Co., bituminous,	490.31	-	-	-	-	7 65
Shaftsbury Coal & Coke Co., bituminous,	-	1,506.43	-	-	-	7 37
John E. Cousens Coal Co., bituminous,	-	108.28 ⁵	-	-	-	10 51
C. W. Clafin & Co., anthracite screenings, . . .	271.74	-	-	-	-	4 21
C. W. Clafin & Co., anthracite screenings, . . .	-	350.52	-	-	-	3 25
Dexter & Carpenter Inc., anthracite screenings, .	473.59	-	-	-	-	4 47
Dexter & Carpenter Inc., anthracite screenings, .	-	1,241.26	-	-	-	4 29
H. N. Hartwell & Son Inc., anthracite screenings,	-	141.47	-	-	-	4 11
E. Russell Norton, bituminous,	-	-	640.98	-	-	9 49

¹ Hoisted from cars and wheeled to bins.

² Dumped from cars into bins.

³ Unloaded at freight yard, teamed 1½ miles and dumped into bins.

⁴ Includes cost of unloading coal from cars and all expenses incidental to the storage of the coal except as otherwise noted.

⁵ Delivered at station by truck.

DEALERS.	STATIONS (AMOUNT IN GROSS TONS).					Cost per Gross Ton in Bins. ⁴
	Chestnut Hill No. 1. ¹	Chestnut Hill No. 2. ²	Spot Pond. ³	Arlington. ²	Hyde Park. ²	
E. Russell Norton, bituminous,	-	-	205.20 ⁶	-	-	6 64
Shaftsbury Coal & Coke Co., bituminous,	-	-	12.61 ⁶	-	-	9 14
Locke Coal Co., anthracite screenings,	-	-	493.05	-	-	5 39
Peirce & Winn Co., bituminous,	-	-	-	40.91 ⁵	-	9 60
E. Russell Norton, bituminous,	-	-	-	48.08	-	8 26
Shaftsbury Coal & Coke Co., bituminous,	-	-	-	199.91	-	7 70
Garfield & Proctor Coal Co., bituminous,	-	-	-	153.81	-	4 56
Dexter & Carpenter Inc., anthracite screenings,	-	-	-	161.10	-	4 92
C. W. Clafin & Co., anthracite screenings,	-	-	-	79.75	-	4 07
E. Russell Norton, bituminous,	-	-	-	-	37.05	8 84
Garfield & Proctor Coal Co., bituminous,	-	-	-	-	88.66	4 40
Sawtelle Coal Co., anthracite screenings,	-	-	-	-	45.04 ⁵	5 32
Roxbury Coal Co., anthracite screenings,	-	-	-	-	83.56 ⁵	3 92
Roxbury Coal Co., anthracite screenings,	-	-	-	-	44.64 ⁵	3 64
Sawtelle Coal Co., anthracite screenings,	-	-	-	-	36.34 ⁵	3 64
Total, bituminous,	1,494.20	2,893.46	858.79	442.71	125.71	-
Total, anthracite screenings,	745.33	1,733.25	493.05	240.85	209.58	-
Average cost, bituminous: —						
In bins,	\$5 55	\$6 16	\$8 81	\$6 85	\$5 71	-
On cars,	5 25	6 03	-	6 75	5 52	-
Average cost, anthracite screenings: —						
In bins,	4 38	4 06	5 39	4 64	4 11	-
On cars,	4 11	3 89	-	4 47	-	-

¹ Hoisted from cars and wheeled to bins.² Dumped from cars into bins.³ Unloaded at freight yard, teamed 1½ miles and dumped into bins.⁴ Includes cost of unloading coal from cars and all expenses incidental to the storage of the coal except as otherwise noted.⁵ Delivered at station by truck.⁶ Hoisted from cars, dumped into trucks, transported 13 miles and dumped into bins.

During the first half of the year the bituminous coal was purchased under contracts made in 1916 and specifications which had been in use for several years. Under these contracts the price per gross ton was reduced 2 cents for each 50 heat units or fraction thereof less than 14,700 per pound of dry coal and 1 cent for each one-half of 1 per cent. or fraction thereof of ash in the dry coal

in excess of 8 per cent.; and for each 50 heat units or fraction thereof in excess of 14,800 per pound of dry coal the price per ton was increased 1 cent, and weights of coal as received at Chestnut Hill pumping stations were corrected for moisture in excess of 3 per cent.

During the last half of the year bituminous coal was purchased for the Spot Pond pumping station under similar specifications, with standards of 14,500 and 14,600 heat units per pound of dry coal, but for the Chestnut Hill and Arlington pumping stations the bituminous coal was purchased under revised specifications which provided that the price should vary in direct proportion with the heating value from a basis of 14,300 heat units per pound of dry coal, and in inverse proportion with the percentage of ash from a basis of 9 per cent.; and for the Chestnut Hill pumping station the weight of coal as received was corrected to a standard of 3 per cent. moisture.

During the first half of the year the anthracite screenings were not purchased under specifications, but during the last half of the year screenings were purchased under specifications which provided that the quality of the dry coal should approximate a standard of 12,500 heat units per pound, 9 per cent. volatile matter and less than 16 per cent. ash, and that for each one-half of 1 per cent. or fraction thereof of ash in the dry coal in excess of 20 per cent. the price per gross ton should be decreased 2 cents and coal which contained more than 25 per cent. of ash might be rejected.

Contracts made during the last half of the year contained a provision that the Commonwealth would assume the payment of all increases in freight charges that might take effect during the term of the contract.

During July we were unable to obtain shipments of bituminous coal from the mines to the Chestnut Hill pumping station in sufficient quantity to supply our needs and it became necessary to purchase 108 gross tons from a local dealer.

Before the 1917 contracts were made for coal for the pumping stations an investigation was made to see if it would be advantageous to substitute fuel oil for coal and it was found that there was fully as much uncertainty about obtaining the oil when needed as there was about obtaining the coal, and that the cost of making steam would be increased if fuel oil should be used.

The results of analyses of the bituminous coal purchased for the pumping stations during 1917 are as follows:—

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percent- age of Volatile Matter.	Percent- age of Ash.	Percent- age of Moisture.	Percent- age of Fixed Carbon.
Davenport,	35	14,590	19.46	7.76	2.71	72.78
Ake Mine,	28	14,157	23.50	10.17	4.18	66.33
Peacock,	5	14,206	20.81	10.17	3.96	69.02
Wendell,	1	14,483	20.56	8.55	2.40	70.89

Chestnut Hill Pumping Stations.

A $2\frac{1}{2}$ kilowatt direct-current electric generator was installed at Chestnut Hill pumping station No. 1 and is operated from the Pelton water wheel for lighting the machine shop and store room, the garage and the basements and other places at both stations, which did not receive illumination during the day time when the main lighting plant was not in operation.

A double-coil feed-water heater has been purchased for utilizing the exhaust steam from the dynamo engine at station No. 2 but has not yet been installed. It will replace the heater now in use temporarily, belonging in station No. 1 which is now held in reserve most of the time. One of the coils in the new heater has a heating surface of 40 square feet for heating the feed water to the low-service boilers and the other coil has a heating surface of 60 square feet for heating the feed water to the high-service boilers.

The 4-inch cast-iron flange pipe blow-off drain from the boilers at station No. 2, which was broken in several places, was relaid with 4-inch bell and spigot cast-iron pipe with lead joints for the entire length of 105 feet inside of the station. In connection with this work brick walls were carried down below the floor on both sides of the pipe, the bottom of the trench was covered with broken stone and removable concrete slabs were set in the floor above the pipe to form a conduit so that in the future leaks may be readily repaired.

All outside overhead electric wires about the pumping stations were removed and put in underground conduits and a private telephone system with six stations was installed for use between the various buildings.

At these stations a daily average of 36,216,100 gallons of water was pumped to supply the southern high-service district and the southern extra high-service pumping station, and a daily average of 19,216,400 gallons was pumped to supply the southern low-service district. Compared with the pumpage of 1916 this is an increase of 1,844,800 gallons per day for the high service. The low-service pumpage in 1916 and in 1917 was not directly comparable because a portion of the supply for the low-service district was at times delivered by gravity from the Weston Aqueduct supply mains.

The pumping statistics for 1917 are as follows:—

Southern High-service Statistics.

	PUMPING STATION No. 1.			PUMPING STATION No. 2.	Totals.
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Engine No. 12.	
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000	40,000,000	106,000,000
Total quantity pumped (million gallons),	1,016.02	10.02	2,824.12	9,368.71	13,218.87
Daily average quantity pumped (gallons),	2,783,600	27,500	7,737,300	25,667,700	36,216,100
Bituminous coal used in pumping (pounds),	1,490,563	17,414	1,415,349	3,925,849	6,849,175
Anthracite screenings used in pumping (pounds),	582,980	2,600	577,301	2,316,677	3,479,558
Average lift (feet),	133.48	116.65	120.36	121.70	122.32
Cost of pumping: —					
Labor,	\$4,888.09 ¹	\$47.69 ¹	\$6,986.38 ¹	\$10,844.26 ²	\$22,766.42
Fuel,	6,013.11	49.06	4,716.21	15,589.24	26,367.62
Repairs,	1,427.05	12.40	1,888.82	2,106.26	5,434.53
Oil, waste and packing,	97.43	.90	139.83	400.23	638.39
Small supplies,	151.35	1.48	216.33	195.79	564.95
Totals,	\$12,577.03	\$111.53	\$13,947.57	\$29,135.78	\$55,771.91
Cost per million gallons pumped,	\$12.3787	\$11.1307	\$4.9387	\$3.1099	\$4.2191
Cost per million foot gallons, . . . . .	.0927	.0954	.0410	.0256	.0345

¹ Operation and care of station with machinery held in reserve a large portion of the time.

² Operation only.

Southern Low-service Statistics.

	Chestnut Hill Pumping Station No. 2. — Engines Nos. 5, 6 and 7.
Daily pumping capacity each engine (gallons),	35,000,000
Total quantity pumped (gallons),	7,013,970,000
Daily average quantity pumped (gallons),	19,216,400
Bituminous coal used (pounds),	2,384,400
Anthracite screenings used (pounds),	1,470,210
Average lift (feet),	33.24

Cost of pumping: —

Labor,	\$16,609 56
Fuel,	9,571 76
Repairs,	3,860 28
Oil, waste and packing,	263 71
Small supplies,	231 70
Total,	<hr/> \$30,537 01

Cost per million gallons pumped,	\$4. 3537
Cost per million foot gallons, . . . . .	. 1310

Spot Pond Pumping Station.

During the year the lockers, wash bowls and shower baths located in the basement below the engine-room were enclosed by wooden partitions and a heating coil was installed so that the room can be comfortably heated during cold weather without heating the entire basement.

Orders were placed during the year for an 18-inch Pelton water wheel and a $2\frac{1}{2}$ kilowatt direct-current generator for lighting the station during the night when the steam plant is not in operation and for lighting the department house, which is located near the station, and will be occupied by the foreman in charge of the reservoirs and grounds in this vicinity; for a Hagan steam-jet ash conveyor, which will discharge the ashes into a steel storage tank elevated so that a truck can be driven under it and loaded through a hopper in the bottom of the tank, and for a Venturi meter and register for measuring the boiler feed water. Owing to delays in delivery of materials, none of these improvements has been completed.

All of the water supplied to the northern high-service district during the year was pumped at this station with the exception of a supply for the towns of Swampscott and Nahant from 7.45 A.M. December 23 to 5.30 P.M. December 24, while a break in the 16-inch northern high-service main in Broadway, Revere, was being repaired.

The northern high-service pumping statistics for 1917 are as follows:—

Total quantity pumped (gallons),	2,802,560,000
Daily average quantity pumped (gallons),	7,678,200
Bituminous coal used (pounds),	1,878,768
Anthracite screenings used (pounds),	997,431
Average lift (feet),	130.08
Engine No. 8 operated (hours),	155
Engine No. 9 operated (hours),	3,260
Quantity pumped by Engine No. 8 (gallons),	68,840,000
Quantity pumped by Engine No. 9 (gallons),	2,733,720,000

Cost of pumping:—

Labor,	\$10,698 99
Fuel,	9,358 07
Repairs,	2,324 30
Oil, waste and packing,	343 00
Small supplies,	316 58

Total for station,	<u>\$23,040 94</u>
------------------------------	--------------------

Cost per million gallons pumped,	\$8.2214
Cost per million foot gallons, . . . . .	.0632

Arlington Pumping Station.

All of the water for the northern extra high-service district was pumped at the Arlington pumping station from the northern low-service mains. The pumping statistics for 1917 are as follows:—

Total quantity pumped (gallons),	313,230,000
Daily average quantity pumped (gallons),	858,200
Bituminous coal used (pounds),	902,040
Anthracite screening used (pounds),	378,920
Average lift (feet),	282.61
Engine No. 10 operated (hours),	6,273
Engine No. 11 operated (hours),	225
Quantity pumped by Engine No. 10 (gallons),	305,410,000
Quantity pumped by Engine No. 11 (gallons),	7,820,000

Cost of pumping: —	
Labor,	\$8,805 91
Fuel,	3,580 16
Repairs,	886 48
Oil, waste and packing,	159 68
Small supplies,	227 68
<hr/>	
Total for station,	\$13,659 91
Cost per million gallons pumped,	\$43.6098
Cost per million foot gallons, . . . . .	.1543

Hyde Park Pumping Station.

All of the water for the southern extra high-service district was pumped at the Hyde Park station from the southern high-service mains. The pumping statistics for 1917 are as follows: —

Total quantity pumped (gallons),	259,390,000
Daily average quantity pumped (gallons),	710,700
Bituminous coal used (pounds),	258,249
Anthracite screenings used (pounds),	412,746
Average lift (feet),	133.17
Engine No. 13 operated (hours),	996
Engine No. 14 operated (hours),	3,229
Quantity pumped by Engine No. 13 (gallons),	60,850,000
Quantity pumped by Engine No. 14 (gallons),	198,540,000
Cost of pumping: —	
Labor,	\$7,424 18
Fuel,	1,277 69
Repairs,	243 63
Oil, waste and packing,	140 66
Small supplies,	235 10
<hr/>	
Total for station,	\$9,321 26
Cost per million gallons pumped,	\$35.9353
Cost per million foot gallons, . . . . .	.2698

Additional information regarding the operation of the pumping engines at the various stations is given on pages 169 to 178.

DISTRIBUTION RESERVOIRS.

The locations and elevations of the distribution reservoirs of the Metropolitan Water Works are shown by the following table: —

DISTRIBUTION RESERVOIRS AND LOCATIONS.	Elevation of High Water. ¹	Capacity in Gallons.
Low Service: —		
Spot Pond, Stoneham and Medford,	163.00	1,791,700,000
Chestnut Hill Reservoir, Brighton District of Boston,	134.00	300,000,000
Weston Reservoir, Weston,	200.00	200,000,000
Mystic Reservoir, Medford,	157.00	26,200,000
Northern High Service: —		
Fells Reservoir, Stoneham,	271.00	41,400,000
Bear Hill Reservoir, Stoneham,	300.00	2,450,000
Northern Extra High Service: —		
Arlington Standpipe, Arlington,	442.00	550,000
Southern High Service: —		
Fisher Hill Reservoir, Brookline,	251.00	15,500,000
Waban Hill Reservoir, Newton,	264.50	13,500,000
Forbes Hill Reservoir, Quincy,	192.00	5,100,000
Forbes Hill Standpipe, Quincy,	251.00	330,000
Southern Extra High Service: —		
Bellevue Reservoir Steel Tank, West Roxbury District of Boston,	375.00	2,500,000
Total,	—	2,399,230,000

¹ Elevation in feet above Boston City Base.

By arrangement with the city of Chelsea a portion of the maintenance of its reservoir on Powder Horn Hill is assumed by the department, and the reservoir is used by the department when necessary in connection with the supplying of water to the northern high-service district. This reservoir has a capacity of 1,000,000 gallons with high-water line at elevation 196.6. The reservoir was in service from January 5 to May 19 and from November 30 to the end of the year, and was kept full for emergency use when not actually in service.

Water is delivered into the Chestnut Hill Reservoir from the storage reservoirs by gravity and is pumped from that reservoir for the low-service and southern high-service districts.

Water is delivered from the Sudbury Reservoir through the Weston Aqueduct by gravity and is then supplied to the low-service works through the Weston Aqueduct supply mains by gravity.

Water for the northern high-service district is pumped from Spot Pond to the Fells and Bear Hill reservoirs. For the northern extra high-service district water is pumped from the low-service pipe lines to the steel tank at Arlington Heights and for the southern extra high-service water is pumped from the southern high-service pipe lines to the Bellevue Reservoir.

Weston Reservoir.

At the Weston Reservoir the inlet chamber, open channel, reservoir lands and screen chamber were cared for, and the walks, driveways, drains and fences were given the necessary attention.

The cellar hole where the attendant's house was removed in 1916 was filled and, together with the old roadway leading to the house, was graded and sown with grass seed. The ironwork at the screen chamber and Ash Street bridge and the stop-planks at the screen chamber were painted.

Chestnut Hill, Fisher Hill and Waban Hill Reservoirs.

The regular work of caring for the gate-houses and screens, shrubs, walks, drives and grounds at the Chestnut Hill, Fisher Hill and Waban Hill reservoirs was attended to as usual.

At the Chestnut Hill Reservoir both basins have been in use throughout the year. The portion of the driveway between the Lawrence and Bradlee basins which was repaired last year was given a final surfacing of Tarvia and fine broken stone at a cost of 10 cents per square yard.

The iron pipe rails of the new fence built last year along Beacon Street on the south shore of Bradlee basin were painted with two coats of red lead paint and one coat of green paint.

The superstructure of the masonry garage which was under construction at the close of 1916 was completed by the contractor June 21, at a cost of \$8,029.85. The plumbing, steam heating apparatus and electric light wiring were installed by the department forces and the garage is now entirely completed, but a little grading remains to be done around the building.

The pumping stations and stable have received the usual attention.

The high Forsythia plants in the large bed at Waban Hill Reservoir at the junction of Manet Road and Ward Street were removed and replaced with 34 low Cotoneaster plants, because of the danger from an obstructed view at this corner.

Some repairs were made to the gate-house at the Fisher Hill Reservoir and the interior was cleaned and painted.

Spot Pond, Fells and Bear Hill Reservoirs.

The usual attention was given to the gate-houses and screens at Spot Pond and the Fells and Bear Hill reservoirs, and to the protection of the trees and care of the water works land at Spot Pond.

Steam-heating apparatus has been installed in the department house at Spot Pond and electric supplies have been purchased for use in installing electric lighting service from the pumping station. The row boat and motor boat were painted and varnished, the engine in the motor boat was overhauled and put in good condition and the boat-house and tool-house were painted. The foot paths have been resurfaced with cinders.

Bellevue and Forbes Hill Reservoirs.

The Bellevue Reservoir has been in service throughout the year. The grading and seeding of the area about the reservoir, which was disturbed during its construction, was completed and a removable closet was erected around the Venturi meter and recording gage to prevent the water in the small pressure pipes from freezing during cold weather.

At Forbes Hill the steel tank has been in regular use all the year and the reservoir has been held full of water for emergency use. The iron stairs leading to the top of the tower were scraped and painted and the interior of the gate-chamber has been cleaned and painted. In connection with the rebuilding of the fence on the south side of the reservoir lot 49 4-inch x 4-inch reinforced concrete posts faced with hard pine strips have been set $16\frac{1}{2}$ feet apart ready for the galvanized iron wire, which has been received but has not been strung because workmen have not been available.

Arlington and Mystic Reservoirs.

Some minor repairs were made to the stairway leading to the top of the Arlington standpipe, which has been in service throughout the year. The grounds around the standpipe have been cared for by the town of Arlington under an agreement made with this department.

The Mystic Reservoir was not in service during the year but has been kept full of water for emergency use. The roadway around the reservoir has been resurfaced. Early in July the two long flights of steps on the northwesterly embankment were removed and entrance to the remaining steps was closed with wire fencing and "no admittance" signs were posted.

Mystic Lake, Conduit and Pumping Station.

Since these structures were abandoned for water supply purposes in 1898 they have been given only such attention as is necessary to keep them in proper repair.

At Mystic Lake the gate-house was painted and the bridge over the dam at the outlet was repaired. Some additional stone bounds were set to define the boundaries of the water works land. Wire was strung on the fence posts set last year for a distance of 826 feet south of the lake and 560 feet of standard wire fencing was erected on the northerly side.

Extensive repairs were partially completed at the house near the station. The clapboards and finish were removed and the building was covered with stucco lathing, a piazza was built on the front of the house and a porch 12 feet wide over the front door. These were also covered with stucco lathing and the whole exterior except the rear of the house was given a coat of three-ply stucco work.

Grounds at Arlington and Hyde Park Pumping Stations.

At the Arlington and Hyde Park pumping stations the lawns and shrubs have been given the usual attention. The side track at the Arlington station was repaired by the Boston & Maine Railroad at a cost to this department of \$56.98, and the siding at the Hyde Park station was repaired by the New York, New Haven & Hartford Railroad at a cost to this department of \$236.74.

During the latter part of the year the exterior woodwork at the

Arlington pumping station was given two coats of paint at a cost of \$164, and the exterior woodwork at the Hyde Park pumping station was also given two coats of paint at a cost of \$136.55.

Protection of Water Supply.

Special watchmen were employed at the Chestnut Hill, Fells, Mystic and Bear Hill reservoirs and at Spot Pond, as required during the year, to prevent violation of the sanitary rules and regulations.

DISTRIBUTION PIPE LINES.

The length of distribution pipe lines owned and operated by the department at the close of the year is 122.34 miles, an increase of 0.07 of a mile during the year. In connection with the maintenance of the pipe lines they have been regularly patrolled and the work of municipalities and public service corporations in the vicinity of the pipe lines has been inspected. The location of each valve chamber has been plainly stenciled on objects along the line so that valves can be readily found when desired. The valves have been kept in good working condition, the valve chambers were cleaned and the frames and covers were regulated to conform to the grades of the streets where necessary. The covers over important valves were covered with salt during cold weather to keep them free from ice.

In connection with the laying of granite block pavement on concrete base in Williams Street near Broadway, by the city of Chelsea, a section of the 20-inch main which was laid by the city of Boston in 1849 and acquired by this department in 1899 was relocated for a distance of 170 feet, where it was laid with shallow cover over the 24-inch main which is also located at this place. The cost of this work was \$953.63.

For the improvement of the supply to the Hyde Park district of the city of Boston, connection was made December 8 between the Metropolitan Water Works 20-inch southern high-service main and the local main in Hyde Park Avenue at Glenwood Street. A 12-inch gate valve and a check valve were installed on this connection.

Pipe Bridges.

Extensive repairs were made to the pipe boxes at the bridges over both branches of the Pines River in Revere and Saugus in connection with the repairs made by the Massachusetts Highway Commission

at these bridges. The work included the removal of the main timbers on the sides of the box and part of the flooring and all of the top at the bridge over the northern branch of the river, and the boxes at both bridges were thoroughly cleaned and painted. The cost of these repairs was \$551.31.

In August the pipe box was rebuilt at the bridge over the Boston & Maine Railroad tracks at Massachusetts Avenue in Cambridge, a new floor was laid and sealed with pitch and tar to make it smoke proof and the old top of the box was repaired and replaced. The cost of this work was \$449.09.

Minor repairs have been made at most of the other pipe boxes and bridges which are now all in good condition with the exception of the box at the Chelsea North Bridge where extensive repairs are necessary.

Pipe Yards.

Pipe yards have been maintained at the Chestnut Hill Reservoir and near the Glenwood Station of the Boston & Maine Railroad in Medford as in former years. Minor repairs have been made to the office, carpenter shop and storage-shed at the Chestnut Hill yard and to the buildings at the Glenwood yard, where the interior of the office and the room used as a garage were painted and varnished and the fence along the street was painted.

Meters, Regulating Valves and Recording Pressure Gages.

There are now 69 Venturi meters varying in size from 6 inches to 60 inches in diameter; 6 Hersey detector meters; 3 Hersey disc meters and 1 Hersey torrent meter connected with the distribution mains, which, with the exception of 10 of the Venturi meters, were used for measuring the water supplied to the various municipalities in the Metropolitan Water District.

In connection with the operation of these meters two men were employed continuously during the year and some additional labor was furnished for this work from time to time as required. The Venturi meter registers were read and the clocks wound twice each week, and they were given such additional attention as was necessary to keep them in repair and operating satisfactorily.

There are now 8 pressure regulating valves installed on the distribution mains for reducing the pressure of the water supplied to portions of Chelsea, East Boston and Hyde Park, and to Nahant,

Revere, Swampscott and Winthrop. The regulating valve at Beach Street, Revere, was in service from January 1 until May 3. The controlling valves of the Ross regulators at Nahant and at Beach Street, Revere, were overhauled and adjusted by the Ross Valve Company.

The 10-inch regulating valve at the Revere-Winthrop boundary line was removed on February 1 and after it was thoroughly overhauled and adjusted by the Waters Governor Company was put in service again on May 3. The cost of removing, overhauling and adjusting this valve was \$189.13.

All of the other regulating valves have received the usual attention and have controlled the pressures in a satisfactory manner.

Recording pressure gages have been maintained at 22 stations on the Metropolitan Water Works, and a table on pages 202 and 203, showing the elevation of the hydraulic grade line in feet above Boston city base at 18 of these stations for each month during the year, has been prepared from the charts.

A connection to the recording pressure gage at the fire engine house on Broad Street, in Lynn, was relaid on account of changes made at this place by the city. On account of the severe electrolytic pitting of the old lead pipe, which was laid in 1906, the new pipe was laid inside of a 4-inch vitrified clay pipe for a distance of 50 feet to protect it from this action. On account of this change the gage was out of service from September 18 to November 8.

Breaks and Leaks.

February 14, about 6.35 A.M., a break occurred in the 30-inch low-service main on Boylston Street at Boylston Place, in Brookline. This pipe was laid by the city of Boston in 1848 and was acquired from the city in 1913. Notice was received by the department of the location of the break at about 6.50 A.M. and the line was shut off by 8 A.M. At the point where the break occurred the pipe trench had been excavated through ledge and the pipe was supported on brick piers. The pipes were about $8\frac{1}{2}$ feet in length and there was one pier about 2 feet back of each bell. The area of the hole which was blown in the side of the pipe was about 28 square feet and water flowed from it at the rate of about 72,000,000 gallons per day for about 30 minutes. The flow then gradually diminished as the gates were closed. The estimated amount of water which flowed

from the pipe is 3,000,000 gallons. It washed away the surface of Boylston Place and Cameron Street and flooded the basements of several houses to variable depths of from 4 inches to $4\frac{1}{2}$ feet. Beyond Cameron Street the water followed the Boston & Albany Railroad tracks and entered Muddy River at a point about 4,000 feet from the break. The street surfaces were repaired by the Brookline Street Department. The basements of the houses were pumped out and cleaned by department forces. Repairs to the pipe line were completed on the 18th and the line was left under pressure until the 19th, when it was again put into service. The total expenditures on account of the break amount to \$1,826.08.

On November 17 a crack about 5 feet in length developed in the 48-inch pipe in Clinton Road, Brookline, 145 feet east of Dean Road. This pipe line was laid by the city of Boston in 1869 and was acquired from the city in 1913. The gates were closed as soon as the leak was reported and before any damage was done, as the water which escaped flowed off through a street catch basin. The pipe line was repaired and was again put into service on November 24. The cost of the work was \$619.78.

December 23 a crack 18 inches long developed in the 16-inch pipe in Broadway near Winthrop Street, Revere. The pipe was repaired and the line was again put in service on the 24th. The water from the break entered the basements of two stores, which were thoroughly cleaned and put in good condition by the department forces. The total expenditure on account of the break was \$145.25.

January 17 a leak developed at the bottom of a joint on a 48-inch $\frac{1}{2}$ -curve in the southern high-service pipe line at the Arborway, near South Street, Forest Hills. This leak appeared to have been caused by settlement, resulting from the excavation of a tunnel under the pipe line a few years previously for the Metropolitan sewer. The cost of repairing this leak was \$476.95.

February 27 the work of repairing a joint leak in the 36-inch upstream pipe line under the Malden River was begun. A scow 24 feet x 60 feet, equipped with derrick, engine and 6-inch centrifugal pump, and a diver were used for this work. After excavating around the pipe by using the centrifugal pump and water jet it was found that the lead joint had been worn away by sand-blast action of the escaping jet of water. Repairs were made by using lead wool. The entire cost of the work was \$851.15.

Between May 16 and 19 a leak was repaired at a taper joint in the down-stream line of the 36-inch submerged pipes under the Charles River at the foot of Magazine Street in Cambridge. An outfit consisting of a pontoon equipped with a steam boiler and 6-inch centrifugal pump, and a diver, were used for this work. The diver found that the lead was partially out of the taper joint for the entire circumference and it was redriven and patched with lead wool. The total cost of the work was \$525.57.

July 10 a joint leak developed in the 30-inch cement pipe in Broadway at Winchester Street, Somerville. This leak appeared to be due to a concrete duct which settled on the pipe. It was repaired at a cost of \$139.71.

There were 39 minor joint leaks in the mains during the year. Sixteen of these leaks were from defective wooden joints, which were repaired at a cost of \$283.08 and the remainder were for the most part from lead joints and were probably caused by slight settlements in the pipe lines, which were repaired at a cost of \$253.27.

Emergency Pipe Line Service.

The two $\frac{3}{4}$ -ton auto trucks, equipped with special bodies and gate-operating attachments, which were put into service last year for operating valves quickly in case of emergency, have been in service during the entire year. One of the trucks is stationed at the Chestnut Hill pipe yard in Brighton for the southern division and the other is stationed at the Glenwood pipe yard in Medford for the northern distribution pipe system. Men are kept on duty ready to operate the trucks in case of emergency at any time during the day or night.

CONSUMPTION OF WATER.

The total quantity of water furnished to the 18 municipalities supplied from the Metropolitan Water Works during the year, as measured by the water works meters was 40,161,778,000 gallons, which is equivalent to an average consumption of 110,032,300 gallons per day. On the basis of an estimated population of 1,215,840 this is equivalent to a consumption of 90 gallons per capita per day. This is an increase of one gallon per capita or 1.1 per cent. in the average daily per capita consumption during 1917 over the consumption of 1916. This is probably due in part to the increased industrial activity on account of the war, and in part to the in-

tentional waste of water to protect the house fixtures from frost during the unusually cold weather in February and December, and to the use of water on lawns and gardens during the unusually hot dry weather in July and August. For an entire week the consumption averaged 129,425,000 gallons per day in February and 123,324,000 gallons per day in August, as compared with an average of 100,026,000 gallons per day for an entire week in November when the consumption was at a minimum rate.

Diagrams following page 102 show graphically the results accomplished in the reduction of consumption by the installation of meters on service pipes.

The average daily consumption of water in each of the municipalities supplied from the Metropolitan Water Works during 1916 and 1917, as measured by the Metropolitan Water Works meters, is as follows:—

	Estimated Popula- tion, 1917.	AVERAGE DAILY CONSUMPTION.				Increase in Gallons.
		1916.		1917.		
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.	
Boston,	776,520	80,358,800	105	82,073,200	106	1,714,400
Somerville,	91,060	6,183,600	69	6,676,100	73	492,500
Malden,	51,160	2,460,200	49	2,419,300	47	40,900 ¹
Chelsea,	46,300	3,070,900	68	3,188,500	69	117,600
Everett,	39,780	2,891,400	74	3,033,000	76	141,600
Quincy,	43,110	2,499,400	59	2,706,800	63	207,400
Medford,	33,340	1,487,000	46	1,641,300	49	154,300
Melrose,	17,560	781,800	45	902,900	51	121,100
Revere,	28,070	1,591,200	59	1,615,400	58	24,200
Watertown,	17,900	1,125,500	65	1,584,600	89	459,100
Arlington,	16,290	929,400	59	997,100	61	67,700
Milton,	9,050	371,300	42	375,000	41	3,700
Winthrop,	14,040	707,800	53	727,200	52	19,400
Stoneham,	7,680	437,900	58	531,300	69	93,400
Belmont,	8,940	447,800	52	474,800	53	27,000
Lexington,	5,790	389,400	69	426,700	74	37,300
Nahant,	1,480	159,000	110	155,300	105	3,700 ¹
Swampscott,	7,776	445,400	59	503,800	65	58,400
District,	1,215,840	106,337,800	89	110,032,300	90	3,694,500

¹ Decrease.

The average consumption in the several districts was as follows:—

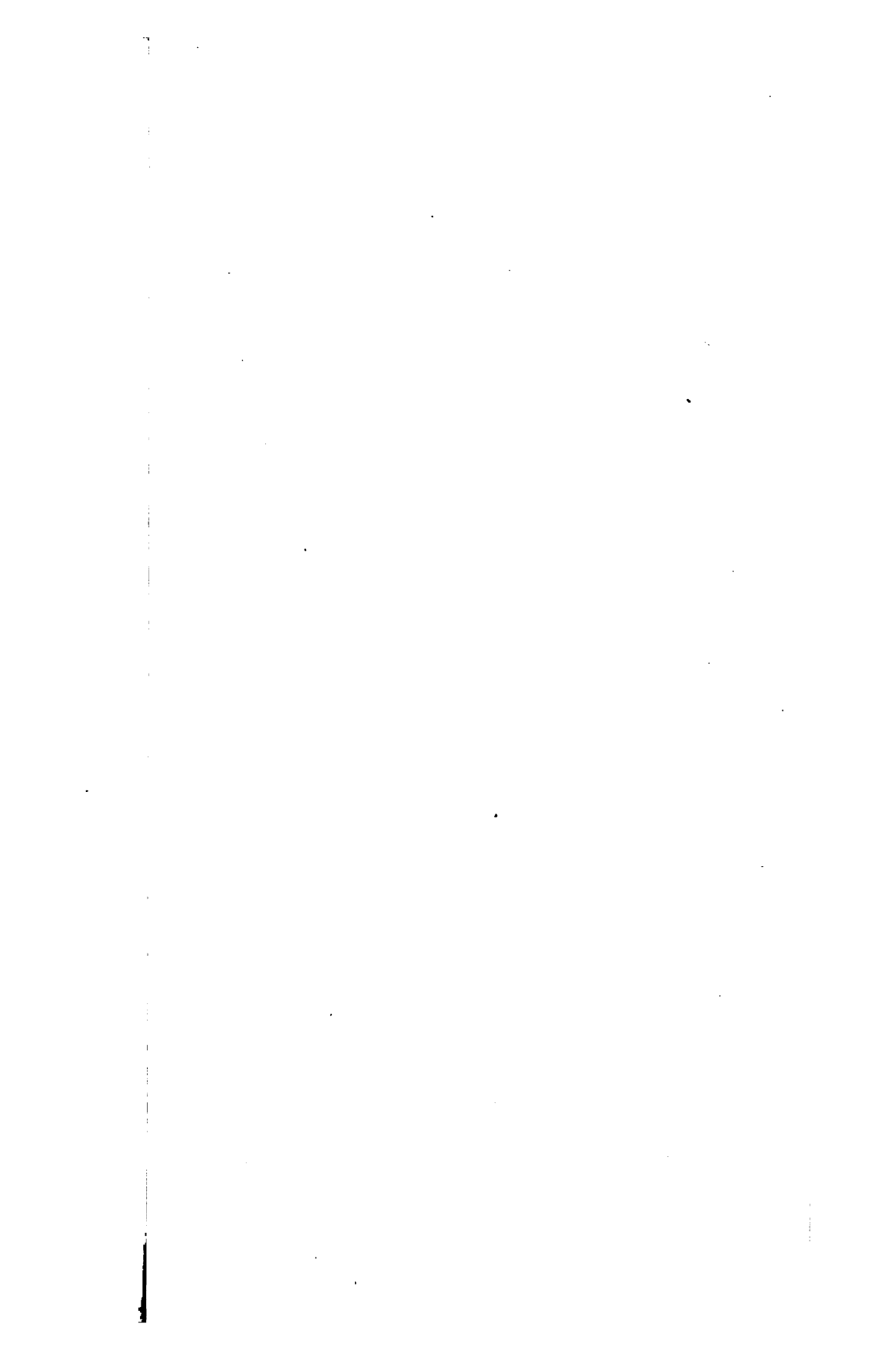
	Gallons per Day, 1917.	INCREASE FROM 1916.	
		Gallons per Day.	Percent- age.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, . .	42,749,100	616,200	1.46
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, . .	22,418,300	1,079,900	5.06
Southern high-service district, embracing Quincy and Watertown, the high-service districts of Boston, and portions of Belmont and Milton, . .	35,174,400	1,408,200	4.17
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, . .	8,124,400	480,800	6.29
Southern extra high-service district, embracing the higher portions of Hyde Park, Milton and West Roxbury, . .	688,400	32,400	4.94
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, . .	877,700	77,000	9.62
Totals,	110,032,300	3,694,500	3.47

Installation of Meters on Service Pipes.

Chapter 524 of the Acts of the year 1907, as amended by chapter 177 of the Acts of the year 1909, requires that in municipalities supplied with water from the Metropolitan Water Works meters shall be set each year on all new service pipes and on 5 per cent. of all service pipes that were without meters on December 31, 1907, and that it shall be the duty of the Metropolitan Water and Sewerage Board to supervise and promote the enforcement of the provisions of this act.

Chapter 269 of the Special Acts of the year 1917 provides that the requirement that meters shall be set each year on 5 per cent. of all services that were not equipped with meters on December 31, 1907, shall not apply to the city of Boston for a period of one year after the passage of this act.

Information regarding the installation of meters on service pipes by the municipalities supplied with water from the Metropolitan Water Works to December 31, 1917, is given in the table on page 103. From this table it may be seen that the total number of meters set on both old and new service pipes since 1907 in each of the municipalities is equal to or exceeds the total number of meters required by the statute to be set to December 31, 1917, although there has been some departure from an exact compliance with the law in certain years.



1

2

3

4

5

6

7

8

9

10

11

12

13

14

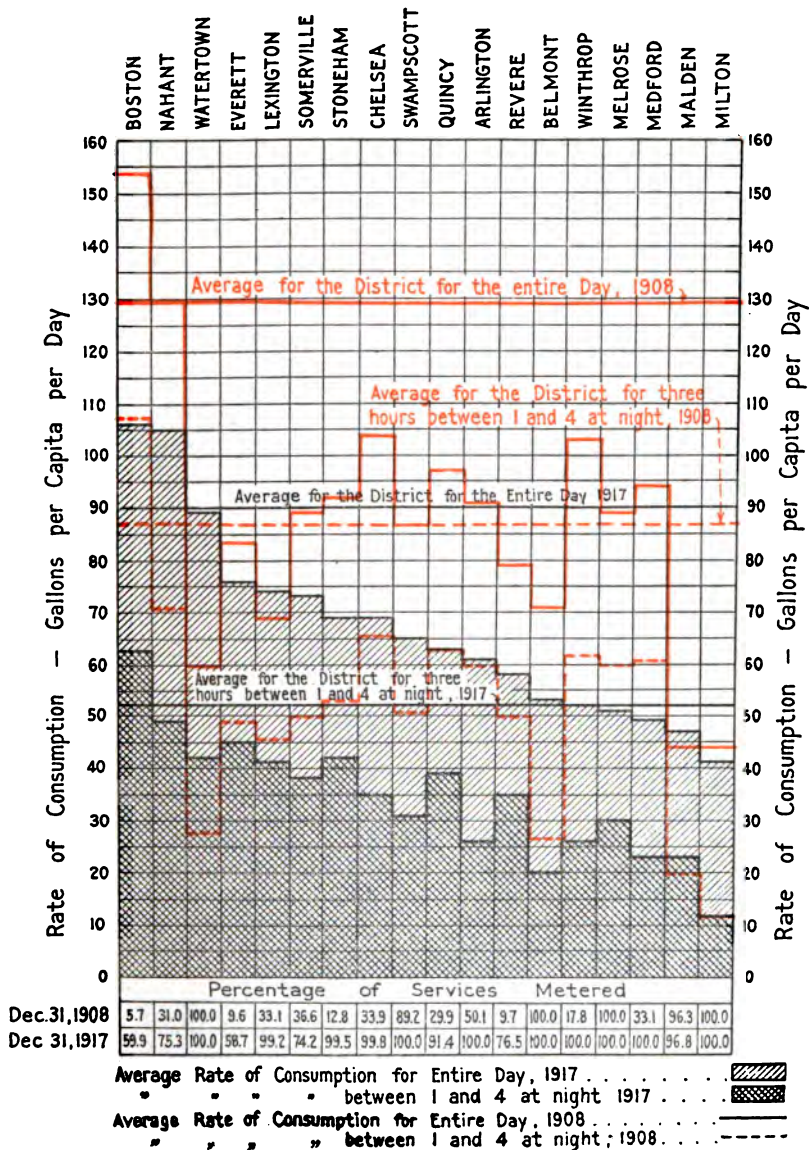
15

16

17

18

AVERAGE RATE OF CONSUMPTION OF WATER IN THE METROPOLITAN WATER DISTRICT FOR THE ENTIRE DAY AND FOR THREE HOURS BETWEEN 1 AND 4 AT NIGHT



CITY OR TOWN.	METERS SET ON OLD SERVICES.										NEW SERVICES.				Meters in Use December 31, 1917.	Per Cent. of Services Installed December 31, 1917.	
	Number of Meters required to be set on Old Services Each Year.	METERS SET ON OLD SERVICES.								Number of Meters required to be set on Old Services to December 31, 1917.	INSTALLED.		EQUIPPED WITH METERS.				
		1908 to 1916, inclusive.	1911.	1912.	1913.	1914.	1915.	1916.	1917.		Totals.	1908 to 1916, inclusive.	1917. ¹ Totals.	1908 to 1916, inclusive.			1917. ¹ Totals.
Boston.	4,276	11,068	6,487	6,022	5,600	5,897	5,418	5,802	1,247	47,641	38,280 ²	15,406	1,140	16,546	12,152	925	13,077
Somerville.	411	1,854	570	488	508	422	439	434	163	4,378	4,110	1,923	154	2,077	2,060	154	2,214
Malden.	14	113	2	-	-	2	3	-	-	120	140	1,158	29	1,187	1,011	80	1,091
Chelsea.	240	1,733	1,092	132	33	6	3	2	1	3,002	2,400	1,086	58	1,144	1,059	58	1,117
Everett.	252	870	285	215	235	261	215	237	223	2,541	2,520	912	41	953	852	41	893
Quincy.	230	814	1,680	1,090	647	193	21	16	8	4,469	2,300	3,650	285	3,935	2,939	255	3,194
Medford.	179	3,339	178	6	7	4	-	1	103	3,038	1,790	2,246	196	2,442	2,218	260	2,484
Melrose.	119	2,574	5	-	-	-	12	1	72	2,592	1,190	728	72	800	913	72	885
Revere.	138	379	176	154	157	487	218	62	72	1,705	1,380	1,770	135	1,905	1,549	153	1,702
Watertown.	55	227	127	261	349	-	-	-	-	964	-	1,083	168	1,251	1,181	172	1,353
Arlington.	-	-	-	-	-	-	-	-	-	-	550	1,198	170	1,368	1,225	170	1,395
Milton.	-	-	-	-	-	-	-	-	-	-	728	770	798	728	798	798	798
Winthrop.	100	1,894	6	-	-	8	4	4	37	1,949	-	880	66	946	917	9	926
Stonham.	65	527	155	252	189	100	78	1	17	1,319	1,000	293	13	306	295	11	306
Belmont.	-	-	-	-	-	-	-	-	-	-	-	920	98	1,018	917	101	1,018
Lexington.	32	239	86	95	4	48	67	19	55	613	320	517	37	554	492	37	529
Nahant.	16	96	18	17	4	15	53	32	5	240	160	261	12	273	226	29	255
Swampscott.	21	434	13	-	-	-	-	-	-	447	210	607	59	666	607	59	666
Totals.	6,148	26,161	10,880	8,732	7,735	7,444	6,528	6,607	1,931	76,018	57,000	35,366	2,803	38,169	31,341	2,662	34,003
																182,139	131,589
																	72.20

¹ The number of new meters installed and the number of new services equipped with meters seldom agree for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

² Chapter 269 of the Special Acts of the year 1917 exempts the city of Boston from setting meters on old service pipes for a period of one year.

During 1917 2,803 service pipes and 4,593 meters were installed in the municipalities supplied from the Metropolitan Water Works, and at the close of the year 182,139 service pipes and 131,589 meters were in use; 72.20 per cent. of all the service pipes had been provided with meters; in eight of the municipalities all of the service pipes were equipped with meters and in three other municipalities over 99 per cent. of the service pipes were equipped with meters.

WATER SUPPLIED OUTSIDE OF METROPOLITAN WATER DISTRICT.

During the year 484,052,000 gallons of water were supplied from the Metropolitan Water Works for use outside the Metropolitan Water District as follows:—

PLACES SUPPLIED.	Total Quantity (Gallons).	Average Quantity (Gallons per Day). ¹	Number of Days on which Water was supplied.	Amounts charged for Water supplied.
Westborough State Hospital,	57,387,000	157,000	354	\$1,721 61
Town of Framingham:—				
From Sudbury Aqueduct,	182,300,000	499,452	364	} 4,773 72
From Filter-gallery at Farm Pond, . .	207,800,000	569,300	365	
United States Government:—				
Peddock's Island,	31,859,000	87,300	365	1,833 25
Town of Saugus,	4,706,000	12,900	365	270 00

¹ For the entire year.

PROTECTION OF WATER WORKS STRUCTURES.

Measures which were undertaken for the protection of the water works structures from irresponsible or malicious persons in February, 1916, because of the unsettled conditions, have been continued, and since war was declared additional precautions have been taken which have required the service of a substantial number of men and a material increase in the maintenance expenditures.

QUALITY OF THE WATER.

The yearly average results of the chemical analyses made by the State Department of Health since 1892 and of the biological and bacteriological examinations made in the Metropolitan Water Works laboratory, of water from service taps in Boston since 1898,

are given in tables on pages 191 to 194. The results of chemical and biological examinations of the water from various parts of the system during the year 1917 are given in tables on pages 185 to 190.

ENGINEERING.

In connection with the maintenance of the works the engineering force has made plans, estimates and reports for various projects and improvements; has made record plans of water works lands and structures, surveys and plans of sanitary conditions at premises on the watersheds and for land purchases and takings; has tested meters; made photographs, blueprints and analyses of coal and oil; calculated yields of watersheds; made current meter gagings; kept hydraulic and meteorological records; summarized power station and pumping station records; cared for the recording pressure gages and supervised various operations carried on by the department.

Appended to this report are tables giving additional information relating to the operations of the Metropolitan Water Works for the year 1917 and the usual water works statistics.

Respectfully submitted,

WILLIAM E. FOSS,
Chief Engineer.

Boston, January 2, 1918.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following report of the operations of the Metropolitan Sewerage Works for the year ending December 31, 1917, is respectfully submitted: —

ORGANIZATION.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for removing sewage from the twenty-six municipalities which comprise the Metropolitan Sewerage districts.

The following assistants have been employed during the year: —

Henry T. Stiff,	Division Engineer, in charge of office and drafting room and of the construction work.
Clarence A. Moore,	Assistant Engineer, in charge of maintenance studies and records and of construction work on the North Metropolitan System.
Arthur F. F. Haskell,	Assistant Engineer, in charge of survey work and field work in connection with the Wellesley Extension construction.
Ralph W. Loud,	Assistant Engineer, in charge of survey work and field work in connection with the Reading Extension construction.
George W. Wood,	Assistant Engineer, on Deer Island Outfall Extension.

In addition to the above, the number of engineering and other assistants employed during the year was 19, which includes 3 instrumentmen, 7 inspectors, 2 draftsmen, 5 rodmen and engineering assistants and 2 stenographers.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the Metropolitan Sewerage districts and they remain as given in the last annual report.

The populations of the districts, as given in the following table, are based on the census of 1915.

Table showing Ultimate Contributing Areas and Present Estimated Populations within the Metropolitan Sewerage Districts, as of December 31, 1917.

CITY OR TOWN.		Area (Square Miles).	Estimated Population.
North Metropolitan District.	Arlington,	5.20	16,600
	Belmont,	4.66	9,140
	Boston (portions of),	3.45	109,640
	Cambridge,	6.11	111,890
	Chelsea,	2.24	46,930
	Everett,	3.34	40,240
	Lexington, ¹	5.11	4,220
	Malden,	5.07	51,660
	Medford,	8.35	33,970
	Melrose,	3.73	17,710
	Reading,	9.82	7,520
	Revere,	5.86	28,710
	Somerville,	3.96	91,990
	Stoneham,	5.50	7,720
	Wakefield,	7.65	13,500
South Metropolitan District.	Winchester,	5.95	10,610
	Winthrop,	1.61	14,320
	Woburn,	12.71	16,850
		100.32	633,220
	Boston (portions of),	24.96	270,380
	Brookline,	6.81	36,300
	Dedham, ¹	9.40	11,810
	Milton,	12.59	9,150
	Newton,	16.88	44,980
	Quincy,	12.56	43,660
	Waltham,	13.63	31,550
	Watertown,	4.04	18,210
	Wellesley,	9.89	7,030
		110.76	473,070
Totals,		211.08	1,106,290

¹ Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year there have been built 1.527 miles of Metropolitan sewer within the sewerage districts, so that there are now 113.011 miles of Metropolitan sewers. Of this total, 9.642 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts. The remaining 103.369 miles of sewers and other works have been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the systems: —

NORTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1917.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston:—					
Deer Island,	4' 0" to 9' 0", . . .	1.653	4	—	—
East Boston,	9' 0" to 1' 0", . . .	5.467	25	Shoe factory, . . .	1
Charlestown,	8' 7"×7' 5" to 1' 0", . .	3.292	14	Middlebrook Wool-combing Co., . . .	8
Winthrop,	9' 0",	2.864	13	Navy Yard,	1
				Private building,	1
				Club house,	1
				Fire Department Station, . .	1
				Private building,	1
				Bakery,	1
Chelsea,	8' 4"×9' 2" to 15", . . .	5.230	13	Rendering works,	1
				Metropolitan Water Works blow-off,	1
				Chelsea Water Works blow-off,	2
				Metropolitan Water Works blow-off,	1
				Cameron Appliance Co., . . .	1
Everett,	8' 2"×8' 10" to 4' 8"×5' 1",	2.925	8	Shultz-Goodwin Co.,	1
				Andrews-Wasgatt Co.,	1
				National Metallic Bed Co., . .	1
				Linoide Co.,	1
				Factory,	2
Lexington, ¹	—	—	1	New England Structural Co., .	1
Malden,	4' 6"×4' 10" to 1' 0", . .	5.844 ²	34	Metropolitan Water Works blow-off,	1
				Private buildings,	181

¹ Lexington, although admitted to the Metropolitan Sewerage System in 1897, has not contributed sewage to the Metropolitan trunk lines until the present year as no local sewerage system had been constructed. Connection was made with the Metropolitan sewers September 11, 1916.

² Includes 1.84 miles of sewer purchased from the city of Malden.

NORTH METROPOLITAN SEWERAGE SYSTEM — *Concluded.**Location, Length and Sizes of Sewers, with Public and Special Connections*
— *Concluded.*

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1917.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Melrose, . . .	4' 6" X 4' 10" to 10", . . .	6.099 ¹	38	Private buildings, . . .	114
				Factory, . . .	1
				Railroad station, . . .	1
				Park Department bath house, . . .	1
				Harvard dormitories, . . .	2
				Slaughterhouse, . . .	1
Cambridge, . . .	5' 2" X 5' 9" to 1' 3", . . .	7.209	45	City Hospital, . . .	3
				Street railway machine shop, . . .	1
				Private buildings, . . .	1
				Tannery, . . .	1
				Slaughterhouses (3), . . .	1
				Car-house, . . .	1
				Somerville Water Works blow-off, . . .	1
Somerville, . . .	6' 5" X 7' 2" to 10", . . .	3.577	12	Street railway power-house, . . .	1
				Stable, . . .	1
				Rendering works, . . .	1
				Railroad scale pit, . . .	1
				Armory building, . . .	1
Medford, . . .	4' 8" X 5' 1" to 10", . . .	5.713	24	Private buildings, . . .	9
				Stable, . . .	1
				Police substation, . . .	1
				Tanneries, . . .	6
				Private buildings, . . .	8
				Gelatine factory, . . .	1
Winchester, . . .	4' 6" to 1' 3", . . .	9.470	25	Watch-band factory, . . .	1
				Stable, . . .	1
				Railroad station, . . .	1
				Felt works, . . .	1
				Town Hall, . . .	1
				Bay State Saw & Tool Co., . . .	1
Stoneham, . . .	1' 3" to 10", . . .	0.010	4	-	-
Woburn, . . .	1' 10" X 2' 4" to 1' 3", . . .	0.933	3	Glue factory, . . .	1
				Private buildings, . . .	159
Arlington, . . .	1' 6" to 10", . . .	3.520 ²	42	Railroad station, . . .	1
				Car-house, . . .	3
				Post office, . . .	1
Belmont, ³ . . .	-	-	3	-	-
Wakefield, ³ . . .	-	-	1	-	-
Revere, . . .	4' 0" to 15", . . .	0.136	3	-	-
		63.942 ⁴	312		541

¹ Includes .736 of a mile of sewer purchased from the city of Melrose.² Includes 2.631 miles of sewer purchased from the town of Arlington.³ The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.⁴ Includes 2.787 miles of Mystic Valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1917.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston: —					
Back Bay, . . .	6' 6" to 3' 9", . . .	1.500 ¹	16	Tufts Medical School, . . .	1
				Private house, . . .	1
				Administration Building, . . .	1
				Boston Park Department, . . .	1
				Simmons College buildings, . . .	2
				Art Museum, . . .	3
Brighton, . . .	5' 9"×6' 0" to 12", . . .	6.010 ²	15	Abattoir, . . .	2
				Chocolate works, . . .	1
				Machine shop, . . .	1
Dorchester, . . .	3'×4' to 2' 6"×2' 7", . . .	2.870 ³	13	Paper mill, . . .	3
				Private buildings, . . .	1
				Edison Electric Company Station, . . .	1
Hyde Park, . . .	10' 7"×11' 7" to 4' 0"×4' 1", . . .	4.527	18	Mattapan Paper Mills, . . .	2
Roxbury, . . .	6' 6"×7' to 4' 0", . . .	1.430	—	Private buildings, . . .	1
				Fairview Cemetery buildings, . . .	—
West Roxbury, . . .	9' 3"×10' 2" to 12", . . .	7.600	16	Caledonia Grove buildings, . . .	1
				Parental School, . . .	1
				Lutheran Evangelical Church, . . .	1
				Private buildings, . . .	4
Brookline, . . .	6' 6"×7' 0" to 8", . . .	2.540 ⁴	12	Private building, . . .	2
Dedham, . . .	4'×4' 1" to 2' 10"×3' 1", . . .	2.839	7	Dedham Carpet Mills, . . .	1
Hull, ⁵ . . .	60" pipe, . . .	0.750	—	—	—
Milton, . . .	11'×12' to 8", . . .	3.600	23	Private buildings, . . .	2
Newton, . . .	4' 2"×4' 9" to 1' 3", . . .	2.911	7	Private houses, . . .	7
Quincy, . . .	11' 3"×12' 6" to 24" pipe, . . .	6.845	14	Metropolitan Water Works blow-off, . . .	1
Waltham, . . .	3' 6"×4' 0", . . .	0.001	1	—	—
Watertown, . . .	4' 2"×4' 9" to 12", . . .	0.750 ⁶	5	Factories, . . .	2
				Stanley Motor Carriage Co., . . .	1
Needham, ⁵ . . .	2' 0"×2' 3" to 2' 3"×2' 6", . . .	4.896	—	Knights of Pythias building, . . .	1
Wellesley, ⁷ . . .	—	—	—	—	—
		49.069	147		45

¹ Includes .355 of a mile of sewer purchased from the city of Boston.² Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also .026 of a mile of sewer purchased from the town of Watertown.³ Includes 1.24 miles of sewer purchased from the city of Boston.⁴ Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.⁵ Hull and Needham are not parts of the Metropolitan Sewerage District.⁶ Includes .025 of a mile of sewer purchased from the town of Watertown.⁷ The Metropolitan sewer extends but a few feet into the town of Wellesley.

Information relating to areas, populations, local sewer connections and other data for the Metropolitan Sewerage districts appears in the following table: —

North Metropolitan Sewerage District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METRO- POLITAN SEWERS.	
					Public.	Special.
100.32	633,220	769.92	568,075	89.7	312	541

South Metropolitan Sewerage District.

110.76	473,070	653.17	342,715	72.4	147	45
--------	---------	--------	---------	------	-----	----

Both Metropolitan Sewerage Districts.

211.08	1,106,290	1,423.09	910,790	82.3	459	586
--------	-----------	----------	---------	------	-----	-----

Of the estimated gross population of 1,106,290 on December 31, 1917, 910,790, representing 82.3 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1423.09 miles of local sewers owned by the individual cities and towns of the districts.

These sewers are connected with the Metropolitan systems by 459 public and 586 special connections. During the current year there has been an increase of 20.02 miles of local sewers connected with the Metropolitan systems, and 7 public and 16 special connections.

CONSTRUCTION.

NORTH METROPOLITAN SEWERAGE SYSTEM.**SECTION 1. — DEER ISLAND OUTFALL EXTENSION.**

The contract and general character of this work are described in last year's report.

Work was resumed on this contract July 9, 1917, and was carried on to completion on December 3, 1917. Much delay was occasioned by the unusually stormy weather during the autumn months.

Stone foundation, consisting of granite sills about 2 feet by 2½ feet by 10 feet, was used between Station 2+58 and Station 0+91. From Station 0+91 to Station 0+0 oak piles 11 feet long were driven in bents of two and were capped by 10-inch by 10-inch hard pine secured to the tops of the piles by drift bolts. Two of

these bents were placed under each 9-foot length of 84-inch cast-iron pipe.

Owing to the loose character of the sand and gravel, the trench was dredged to a width on top of about 60 feet. Before backfilling stone riprap buttresses were built on either side against the 84-inch pipe at stations 0+81, 1+25 and 1+60 to prevent displacement while backfilling was being done. A sleeve was introduced in the pipe line at Station 0+32.

The 84-inch cast-iron pipe and specials were covered on the outside with a $\frac{1}{8}$ -inch coating of bitumastic enamel.

EXTENSION TO READING.

No work has yet been done in constructing the Metropolitan sewer extension to Reading as authorized by Chapter 159 of the General Acts of 1916.

Several attempts have been made to place contracts for the upper two sections but owing to the abnormal conditions of the market for supplies and labor, the prices bid have been so much above the original estimated cost that no contracts could be made.

The estimate of cost for this work was made in 1914.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

WELLESLEY EXTENSION.

The Wellesley Extension of the High-level Sewer comprises sections 98 to 106 inclusive. Of these sections 102, 103, 104, 105 and 106 are wholly completed and Section 98 is about 80 per cent. completed.

SECTION 98. — WELLESLEY EXTENSION.

The particulars of this section and the contracts concerning the same are given in last year's report.

Work has been carried on throughout the year and 2,518 feet of sewer have been completed. Great difficulty has been experienced in the work owing to the loose, wet, fine sands encountered. The ground waters have been very high throughout the year and the marshes were flooded in August and October so that work had to be abandoned temporarily. It has been necessary to drive 3-inch matched sheeting nearly all the distance completed. In most places it was driven 7 to 9 feet below grade and the concrete sewer built on a gravel platform. Considerable ground water was found.

Ledge was encountered between Station 9+84 and Station 11+87 and gravel bottom between Station 11+87 and Station 12+60. Reinforcing steel has been used in the concrete except where ledge and gravel bottoms were found.

A temporary corduroy road has been built along the side of the trench leading easterly from Bridge Street.

It is expected this section will be completed in the fall of 1918.

SECTION 99. — WELLESLEY EXTENSION.

This section consists of about 1,300 feet of rock tunnel and 2,000 feet of trench in which is to be constructed a 33-inch by 36-inch concrete sewer. A small amount only of construction work on this section has been accomplished. An attempt to make a contract for this work in 1916 and another in August, 1917, failed as the prices bid were far in excess of the appropriation.

A small portion of this section extending from Station 0+0 to Station 0+66 has been constructed by G. M. Bryne in connection with the construction of Section 98. This work was done to complete that part of the Wellesley Extension extending through the fine sands at this locality. The trench at Station 0+66 reached a bottom of hard ground.

SECTION 100. — WELLESLEY EXTENSION.

No attempt has been made to place this section of 3,900 feet of 33-inch by 36-inch concrete sewer in trench under contract as the appropriation was insufficient.

SECTION 101. — WELLESLEY EXTENSION.

Plans were prepared and on September 26, 1917, bids were opened for the construction of this section of 3,840 feet of 33-inch by 36-inch concrete sewer in trench including a crossing of the Charles River.

No contract was made as all bids, being in excess of the appropriation, were rejected.

SECTION 102. — WELLESLEY EXTENSION.

This section and the contract for the same were described in last year's report.

Ledge was encountered at various points from Station 9+50 to

Station 18+00, from Station 23+50 to Station 27+50 and from Station 54+0 to Station 66+60. Excavations below grade were necessary from Station 0+0 to Station 3+12, from Station 5+10 to Station 8+0, from Station 30+36 to Station 31+20 and from Station 41+10 to Station 43+50. These were refilled with special concrete except from Station 30+36 to Station 31+20 which was refilled with gravel. A small amount of ground water was encountered.

Masonry work on this section was completed December 15, 1917. There remains some grading and cleaning up which will be completed when the weather permits.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 pumping stations, the Nut Island screen-house and 113.011 miles of Metropolitan sewers, receiving the discharge from 1,423.09 miles of town and city sewers at 459 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force includes 160 men, of whom 96 are employed on the North System and 64 on the South System. These are subdivided as follows: North Metropolitan System, 58 engineers and other employees at the pumping stations; on maintenance, care of sewer lines, buildings and grounds, 38 men, including foremen; South Metropolitan System, 35 engineers and other employees within the pumping stations; and 29 men, including foremen, on maintenance, care of sewer lines, buildings and grounds.

The regular work of this department, in addition to the operation of the pumping stations, has consisted of routine work of cleaning and inspecting sewers and siphons, caring for tide gates, regulators and overflows, measuring flow in sewers, inspection of connections to the Metropolitan sewers, care of pumping stations and other buildings and grounds, and the maintenance of the ferry at Shirley Gut for transporting employees and supplies in connection with the operation of the Deer Island pumping station.

In addition to these regular duties other work has been done by this department as follows: —

DEER ISLAND PUMPING STATION.

During this year there has been constructed at this station a new masonry office annex 12 feet by 16 feet with reinforced concrete roof. This adjoins the back of the original engine house and replaces a wooden building formerly used as an office.

The brick walls of the economizer building at this station have been raised 6 feet and a reinforced-concrete roof has been placed over the same. This gives head room enough to make repairs to economizer tubes.

The shaft of the impeller wheel of pump No. 3 has been refitted to the wheel and new tubes were inserted in the wheel. A new bronze sleeve was put on the shaft of this pump.

The lower bearing of pump No. 4, which was formerly of lignum-vitæ with no method of adjustment, has been changed to a bab-bitted brass bearing with adjusting screws to take up the wear.

All work was done by maintenance employees.

EAST BOSTON PUMPING STATION.

A 1,500-gallon steel tank for sea water for condensation purposes has been placed in this station. By the use of this tank all engines can be run through low tide without the use of condensation water from the public water supply.

All work was done by maintenance employees.

CHARLESTOWN PUMPING STATION.

A new well for sea water for condensing purposes has been constructed outside the station. This replaces one built in 1895.

All work was done by maintenance employees.

Changes in the location and elevation of the street in front of this station in connection with the construction of the new highway bridge across Mystic River have been completed during the year. The street has been moved 30 feet to the westward and has been raised about 5 feet at the southerly end of the pumping station lot.

WARD STREET PUMPING STATION.

During the year two 175 horse-power upright boilers of the Dean type have been placed in this station. These were constructed and

placed in position by the D. M. Dillon Steam Boiler Works of Fitchburg.

All connecting piping and flues have been completed by the maintenance employees.

SEATTLE STREET CONDUIT CROSSING.

Arrangements were made with the city of Boston whereby the Metropolitan Water and Sewerage Board changed the size and form of the Metropolitan sewer at about Station 14 of Section D, Brighton, and built a short length of storm water conduit across the Metropolitan sewer at this point. The Board is to be reimbursed by the city for all expenditures.

NUT ISLAND.

At this place a new reinforced concrete boat-house and tool-house with wooden roof has been constructed. This is situated on the easterly side of the island near high-water mark and has dimensions of 56 feet by 23 feet.

All work was done by maintenance employees.

GOVERNMENT USE OF OLD 24-INCH QUINCY FORCE MAIN.

At the new shipbuilding plant at Squantum, Quincy, the United States Government has installed a special sewerage system and pumping plant. Permission was given by the Board to use such part as is needed of the abandoned 24-inch cast-iron main in Squantum Street leading to the Boston Main Drainage System at Squantum Head.

A connection was made to this force main at about Station 132+70. No sewage has yet been discharged through this line.

STUDY OF SEWERAGE IN MILL BROOK VALLEY IN ARLINGTON.

The following study of the sewerage conditions and needs of the towns of Arlington and Lexington has been made in accordance with legislative resolve, chapter 22 of 1917, approved March 8, 1917, which reads —

Resolved, That the metropolitan water and sewerage board shall investigate the condition and capacity of the present metropolitan sewer in the town of Arlington with especial reference to its capacity to receive and dispose of the

sewage of that part of the town of Arlington tributary to the same, and of the town of Lexington. The said board is also authorized and directed to report a plan for the new sewer contemplated by section four of chapter five hundred and twenty of the acts of the year eighteen hundred and ninety-seven, in the valley of Mill or Sucker brook, so situated as to serve all parts of the said valley and such adjacent territory as, in the opinion of the board, should be served by the same. The board may employ such engineering or other assistance as may be necessary, and may incur an expense not exceeding one thousand dollars in carrying out the provisions of this resolve. The board shall report to the present general court not later than the first day of May, with plans and estimates of the cost of such construction as it may recommend.

At present the towns are served by a metropolitan trunk sewer extending the entire length of Arlington and terminating at the easterly boundary of Lexington. This sewer was in part purchased from the town of Arlington and in part constructed by the Metropolitan Sewerage District.

The sewer constructed by the District extends from the Alewife Brook pumping station to a point in Arlington across Alewife Brook known as Section 48, and that portion from Lowell Street near Massachusetts Avenue to the Arlington-Lexington town line, known as Section 53. The portion between Section 48 and Section 53 was purchased from the town and is known as Section 52.

Section 48 was constructed in 1894, and is a part of the original trunk lines of the Metropolitan Sewerage District.

Upon the admission of part of the town of Lexington to the Sewerage District, Section 52 (which previously had been a local sewer built by the town) and Section 53 became parts of the metropolitan trunk system to provide an outlet for the town of Lexington as provided in chapter 520 of the Acts of 1897.

Although Lexington became a part of the Metropolitan Sewerage District at this time, no local sewers were built therein until 1915, and no connection was made to the metropolitan system until September, 1916.

Section 4 of chapter 520 of the Acts of 1897 reads as follows: —

Whenever said portion of the sewer in Massachusetts Avenue shall be insufficient to accommodate the town of Lexington and the portion of the town of Arlington using the same, the metropolitan sewerage commissioners shall construct a new sewer in the valley of Mill or Sucker Brook, in such a location as shall accommodate all portions of said valley.

At the time of the formation of the Metropolitan Sewerage District, Arlington had a population of less than 5,000, and a forecast gave it as having probably 10,000 in 1930. The town has grown much faster than was anticipated and now has a population of 15,300 (approximately). Section 48 was designed to furnish an outlet for a population of 10,000 at the rate of 30 cubic feet per person daily. That part of Lexington included within the Sewerage District has a present population of 4,080, of which only 200 persons are now contributing sewage to the metropolitan sewers. Calculations made in this office based on recent census returns indicate that in 1940 that portion of Lexington in the Metropolitan Sewerage District will probably have a population of 13,000, and that Arlington will have 46,000. To provide for these populations, the metropolitan sewers serving these towns should then have a total capacity of 17,700,000 gallons per day.

The towns of Lexington and Arlington are now served by metropolitan sewers as follows:—

At the Lexington-Arlington town line a 15-inch pipe sewer having a capacity of 2,300,000 gallons per day.

Between Lowell Street and Brattle Street a 12-inch pipe sewer having a capacity of 2,000,000 gallons per day.

Between Brattle Street and Mystic Street a 12-inch pipe sewer having a capacity of 2,400,000 gallons per day.

Between Mystic Street and Alewife Brook pumping station partly 15-inch and partly 18-inch pipe sewer having a capacity of 2,250,000 gallons per day.

Arlington has also two other outlets into the Alewife Brook metropolitan sewer, — one at Henderson Street and one at Lake Street.

The town of Arlington maintains two automatic pumping plants, — one at Brattle Street and one at Grove Street. These lift the sewage from limited areas north of Mill Brook into the metropolitan sewer in Massachusetts Avenue.

At the present time no portion of the metropolitan sewer in Massachusetts Avenue is carrying more than two-thirds of its capacity.

The town of Arlington may be divided into three districts — one to the east of Mystic Street which can be made tributary to a low-level sewer only, like the one now entering the Alewife Brook pumping station (this will have an estimated population in 1940 of about 29,000, and now has three outlets to the metropolitan sewers); the

second portion extends between Mystic Street and Brattle Street, and will have a population in 1940 of probably 10,500; the third part of the town is that lying to the westward of Brattle Street, and will have a population in 1940 of probably 7,500. The two latter divisions with Lexington's contributory population estimated at 12,750 in 1940 will give a total population in Mill Brook valley above Mystic Street of 30,750. This population would require a sewer with a capacity of 9,300,000 gallons per day to provide for these areas.

In studying the problem, it has been thought proper to divide the sewage from Arlington and Lexington into two parts and take the portion from all of the territory in the upper part of the valley across to West Medford and there discharge it into the existing metropolitan sewer at High and Canal streets and continue to take the portion from the remaining part of the town of Arlington, namely, that part east of Mystic Street to the low-level Alewife Brook sewer, as is now being done.

To provide for the disposal from the higher parts a trunk sewer has been studied starting from the corner of High and Canal streets in West Medford extending westerly through High Street, crossing the Mystic River into Arlington and then extending through Medford Street and Hayes Street in and through private lands and Mt. Pleasant Cemetery to a crossing of Mill Brook near Sachem Street and thence through Sachem Street to Mystic Street, then in Mystic Street and part of Summer Street and then in private lands crossing the Boston & Maine Railroad location to Mill Street and then through a proposed street and private lands and land of the Arlington Gas Company to and across Grove Street, thence through Dudley Street to a point in Brattle Street. This sewer will have a total length of about 11,400 feet and will consist of a 36-inch by 42-inch concrete sewer and 24-inch, 20-inch and 18-inch pipe sewers with relief connections extending from the existing metropolitan sewer through Mystic Street and Brattle Street to the proposed trunk line, about 1,550 feet in length.

By this method all of the tributary territory of Lexington and of Arlington to the westward of Mystic Street in Mill Brook valley can be permanently and adequately served.

The Board is not called upon to report upon any part of Arlington not lying in Mill Brook valley.

The construction work study has been limited to that portion east of Brattle Street for the present because it is believed that the town of Arlington can conveniently bring its collecting sewers to this point. While it is proposed at present to consider building only as far as Brattle Street, the needs of the whole valley have been studied, and the line as shown, on the plan extending to the Lexington town line, together with the existing metropolitan sewer, will furnish adequate outlet for this area.

The estimated cost of the construction of this portion of the line with the relief connections is \$350,000. This estimate is based on unit prices named in bids recently received by the Board for sewer work in a territory similar to and not far distant from this work. Prices of material are still advancing and labor is scarce and inefficient and wage rates are rising.

There is no doubt that the construction of a sewer in Mill Brook valley must in a few years be undertaken. The condition, however, named in section 4 of chapter 520 of the Acts of 1897 has not yet arrived.

A map showing the route and profile of the sewer line as studied is on file in this office.

GASOLENE IN PUBLIC SEWERS.

The efforts to improve the condition of the Metropolitan sewers in regard to dangers resulting from the introduction of gasoline into the same have been continued throughout the year and have been successful.

An inspector has been employed in this department whose duty it is to visit existing garages and see that the separators are kept in proper condition, also to enforce the regulation concerning the installation of such separators at all newly constructed garages.

There has been a large growth in the number of places from which gasoline might be discharged into the Metropolitan Sewerage Systems. While the presence of gasoline in the sewers is noted occasionally, the condition has been greatly improved.

The following tables show the particulars in regard to establishments known to be using gasoline and which are connected with the public sewerage systems of the different municipalities in the Metropolitan districts:—

NORTH METROPOLITAN SEWERAGE DISTRICT.

Table showing Number of Places where Gasolene is used connected with Public Sewers and Progress of Work of installing Separators to December 31, 1917.

CITY OR TOWN.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1917.	Number of Places where Changes have yet to be made.
Arlington,	6	-	3	3	-
Belmont,	4	-	2	1	1
Boston: —					
Charlestown District,	19	-	11	8	-
East Boston District,	17	-	7	10	-
Cambridge,	90	-	49	40	1 ¹
Chelsea,	18	-	9	9	-
Everett,	14	-	13	1	-
Lexington,	-	-	-	-	-
Malden,	20	-	19	1	-
Medford,	13	-	10	3	-
Melrose,	5	-	5	-	-
Revere,	9	-	6	3	-
Somerville,	40	8	23	9	-
Stoneham,	6	-	3	3	-
Wakefield,	6	-	4	2	-
Winchester,	14	-	12	2	-
Winthrop,	4	-	4	-	-
Woburn,	3	-	2	1	-
Reading, ²	-	-	-	-	-
Totals,	288	8	182	96	2

¹ Storer's garage.² Not yet connected with Metropolitan sewers.

SOUTH METROPOLITAN SEWERAGE DISTRICT.

Table showing Number of Places where Gasolene is used connected with Public Sewers and Progress of Work of installing Separators to December 31, 1917.

CITY OR TOWN.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1917.	Number of Places where Changes have yet to be made.
Boston: —					
Hyde Park District,	14	—	8	6	—
West Roxbury District,	20	10 ¹	10	13	—
Back Bay District,	48	5	23	20	—
Brighton District,	43	22	21	22	—
Dorchester District,	27	20	7	22	—
Brookline,	60	9	36	15	—
Dedham,	3	3	—	1	—
Milton,	1	1	—	1	—
Newton,	38	18	13	7	—
Quincy,	14	—	12	2	—
Waltham,	5	5	—	2	—
Watertown,	15	3	10	2	—
Wellesley, ¹	—	—	—	—	—
Totals,	288	96	140	113	—

¹ Not yet connected with Metropolitan sewers.

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

Four men and a foreman have been employed during a part of the year in flushing and cleaning the Metropolitan sewers through the tannery districts of Winchester, Woburn and Stoneham.

All the tanneries and glue works of the district now have settling tanks of substantial size. This method of treatment has very greatly reduced the amount of sludge material entering the Metropolitan sewers.

The following table gives details of settling tanks introduced to date, showing the operations of same with the amount of sludge collected and removed: —

Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham, Year ending December 31, 1917.

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during the Year.	Average Quantity Semi-fluid Sludge removed during the Year (Cubic Yards).	Total Quantity Semi-fluid Sludge removed during the Year (Cubic Yards).
Beggs & Cobb Company, Basin No. 1, .	Jan. 15, 1910	47.0 × 23.0	4	136.00	544.00
Beggs & Cobb Company, Basin No. 2, .	May 9, 1910	47.0 × 23.0	4	136.00	544.00
Beggs & Cobb Company, Basin No. 3, .	Oct. 19, 1911	51.0 × 25.0	3	162.50	487.50
Beggs & Cobb Company, "Rotary Screen Process," ¹	Dec. 12, 1917	-	-	-	22.20
S. C. Parker & Son,	Aug. 1, 1910	48.3 × 23.0	2	34.94	69.88
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 × 23.1	5	139.50	697.50
Dorington Leather Company, ²	Dec. 10, 1910	47.2 × 23.0	4	106.84	427.36
E. Cummings Leather Company,	Nov. 1, 1910	45.9 × 22.6	2	97.60	195.20
W. P. Fox & Sons,	July 12, 1910	47.8 × 22.6	4½	270.40	1,216.80
Thayer & Foss,	Sept. 15, 1910	48.1 × 23.1	3½	209.80	734.30
Morris Kaplan,	Jan. 9, 1911 {	46.8 × 22.9	-	-	-
		4.0 × 4.0	50	1.00	50.00
Van Tassell Leather Company,	May 1, 1911 {	10.2 × 14.5	9	16.00	144.00
		43.8 × 19.5	2	102.00	204.00
American Glue Company,	Oct. 1, 1910	47.1 × 23.0	2½	136.36	340.90
J. O. Whitten Company,	1902 {	35.5 × 24.7	26	58.74	1,527.24
		67.2 × 12.0	24	8.50	204.00
Total,	-	-	-	-	7,408.88

¹ By permission of the Board, dated July 25, 1917, effluent formerly passing through three settling basins has been conducted through "Riensch-Wurl" screens and is allowed to enter the Metropolitan Sewer by a special 15" branch.

Permission was granted with the provision that all existing connections and settling basins shall be left intact and ready for use if necessary. One-half of screening plant was operated from December 12 to 31, 1917.

² Successors to B. F. Kimball & Company.

NORTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1917.]

CITIES AND TOWNS.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Deer Island),	70	Separate,	-	-	755 ¹	755 ¹	Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Winthrop,	32.41	Separate,	3,003	4.70	14,115	14,320	1.40	1.61	98.6	87.0
Boston (East Boston),	33.65	Separate and combined,	5,091	12.90	65,075	68,885	1.17	2.18	95.4	53.7
Chelsea,	30.95	Separate and combined,	4,218	10.70	45,135	46,930	1.14	2.24	96.2	50.9
Everett,	47.82	Separate and combined,	5,113	6.90 ²	35,280	40,240	1.99	3.34	87.7	59.6
Malden,	66.26	Separate,	6,989	6.70 ²	46,825	51,660	3.14	5.07	90.6	61.9
Melrose,	39.09	Separate,	3,333	4.50 ²	15,020	17,710	1.87	3.73	84.8	50.1
Boston (Charlestown),	21.26	Separate and combined,	5,428	7.30	39,625	40,000	0.67	1.27	99.1	52.8
Cambridge,	154.78	Separate and combined,	16,751	6.60	110,555	111,890	5.05	6.11	98.8	82.7
Somerville,	101.51	Separate and combined,	15,973	5.65	90,245	91,990	3.50	3.96	98.1	88.4
Medford,	65.16	Separate,	6,094	5.45 ²	33,210	33,970	3.16	3.35	97.8	37.8
Winchester,	31.62	Separate,	1,934	5.20 ²	10,055	10,510	1.51	5.95	94.8	25.4
Woburn,	15.41 ³	Separate,	1,233	5.80 ²	7,180	16,850	1.01	12.71	42.6	7.9
Stoneham,	13.46	Separate,	947	4.80 ²	4,545	7,720	0.70	5.50	58.9	12.7
Arlington,	31.61	Separate,	2,321	5.70 ²	13,230	16,600	1.94	5.20	79.7	37.3
Belmont,	21.60	Separate,	1,287	6.00 ²	8,240 ⁴	9,140	1.33	4.66	90.2	28.5
Wakefield,	14.35	Separate,	1,803	5.50 ²	4,415	13,500	0.60	7.65	32.7	7.8
Lexington,	6.51	-	62	4.30	265	4,220	0.23	5.11	6.3	4.5
Revere,	41.75	Separate,	3,562	6.60	23,705	28,710	2.05	5.86	82.6	35.0
Reading, ⁵	-	-	-	-	-	7,520	-	9.82	-	-
Totals,	769.92	-	84,132	6.70	568,075	633,220	32.46	100.32	89.7	32.4

¹ Estimated by Supt. James H. Burke of the institution on Deer Island.

² Estimated from assessors' statement of the number of houses in the city or town on April 1, 1917, and the population from census of 1915.

³ Exclusive of Mystic valley sewer and tanneries.

⁴ Including 2 connections with McLean Hospital, having an estimated population of 520.

⁵ Reading not connected.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

(Populations estimated as of December 31, 1917.)

CITIES AND TOWNS.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Back Bay),	26.53	Separate and combined,	1,954	20.3	37,635	38,010	Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Brighton),	63.06	Separate and combined,	4,003	8.7	31,825	41,035	1.15	1.61	99.0	71.4
Brookline,	74.43	Separate and combined,	4,921	7.3	35,925	36,300	3.30	3.74	84.9	85.6
Newton,	127.78	Separate,	7,562	5.5 ¹	41,500	44,980	3.63	6.81	99.0	53.3
Watertown,	47.13	Separate,	2,888	5.6	16,060	18,210	7.84	16.88	92.5	46.4
Waltham,	47.38	Separate,	3,890	7.6	29,565	33,550	2.31	16.04	88.2	57.2
Boston (Dorchester),	57.38	Separate and combined,	5,866	9.7	57,775	83,490	2.44	13.83	93.7	17.9
Milton,	17.85	Separate and combined,	2,949	5.0	17,745	19,315	0.87	12.69	69.3	51.5
Boston (Hyde Park),	31.31	Separate,	2,413	7.2	17,375	19,315	1.60	4.57	89.0	35.0
Dorham (Roxbury), ²	17.30	Separate,	866	5.5	4,765	11,810 ³	0.86	9.40	40.3	9.1
Boston (Roxbury), ⁴	60.09	Separate and combined,	4,049	7.3	31,620 ⁴	44,730	2.70	1.23	72.4	30.3
Boston (West Roxbury),	80.25	Separate,	5,818	6.3	30,585	43,660	3.39	8.92	70.6	27.0
Quincy,	-	-	-	-	-	7,050	-	9.89	-	-
Wellesley, ⁵	-	-	-	-	-	-	-	-	-	-
Totals,	653.17	-	45,149	7.6	342,715	473,070	32.61	110.76	72.4	29.4

¹ Estimated from assessors' statement of the number of houses in the city or town on April 1, 1917, and the population from census of 1915.

² Part of town not included in Metropolitan Sewerage District.

³ At present connected with Boston Main Drainage System.

⁴ Including connection with institutions at Austin Farm, having an estimated population of 2,060.

⁵ Wellesley not yet connected with metropolitan sewer.

BOTH METROPOLITAN SEWERAGE SYSTEMS.

Table showing Areas delivering Sewage to both Systems; Approximate Miles of Sewers connected; Estimated Population and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Population estimated as of December 31, 1917.]

SYSTEM.	Miles of Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contribution to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
North Metropolitan,	789.92	Separate and combined,	84,182	6.7	568,075	633,220	Sq. Miles. 32.46	Sq. Miles. 100.32	Per Cent. 89.7	Per Cent. 32.4
South Metropolitan,	683.17	Separate and combined,	48,149	7.6	312,715	473,070	32.61	110.76	72.4	29.4
Totals,	1,423.09	-	129,331	7.0	910,790	1,106,290	65.07	211.08	82.3	30.8

PUMPING STATIONS.**CAPACITY AND RESULTS.**

During the year 1917 the amount pumped at the various pumping stations of the Metropolitan Sewerage Works has decreased from 2.6 per cent. to 15.6 per cent. as compared with last year's pumping.

The total cost of operation of the pumping stations has increased 17 per cent. as compared with that of last year. This increase is due to an advance in the wages of all of the employees and to the very great increase in the cost of fuel and supplies.

Average Daily Volume of Sewage lifted at Each of the Six Principal Metropolitan Pumping Stations and at the Quincy (Hough's Neck) Sewage Lifting Station during the Year, as compared with the Corresponding Volumes for the Previous Year.

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1916, to Dec. 31, 1916.	Jan. 1, 1917, to Dec. 31, 1917.	Decrease during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	66,300,000	64,600,000	1,700,000	2.6
East Boston,	64,300,000	62,600,000	1,700,000	2.6
Charlestown,	37,300,000	36,300,000	1,000,000	2.7
Alewife Brook,	3,847,000	3,393,000	454,000	11.8
Quincy,	4,780,000	4,033,000	747,000	15.6
Ward Street (actual gallons pumped), .	29,864,000	28,457,000	1,407,000	4.7
Quincy (Hough's Neck) sewage lifting station.	187,238	184,799	2,439	1.3

NORTH METROPOLITAN SYSTEM.*Deer Island Pumping Station.*

At this station are four submerged centrifugal pumps with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 55,400,000 foot-pounds.

Average quantity raised each day: 64,600,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 4 oilers, 3 screenmen, 1 relief screenman and 1 laborer.

Coal used: Bituminous, costing from \$5.85 to \$9.60 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1917.						
January,	2,005,900,000	64,700,000	50,400,000	100,800,000	11.18	59,000,000
February,	1,810,800,000	64,700,000	50,400,000	105,000,000	11.20	49,900,000
March,	2,149,400,000	69,300,000	48,600,000	104,000,000	11.48	49,200,000
April,	2,081,500,000	69,400,000	54,700,000	104,200,000	11.19	53,900,000
May,	2,243,600,000	72,400,000	54,700,000	117,700,000	11.84	58,300,000
June,	2,208,200,000	73,600,000	58,800,000	108,300,000	11.19	59,600,000
July,	2,046,800,000	66,000,000	50,900,000	81,900,000	10.69	65,400,000
August,	1,931,500,000	62,300,000	43,800,000	110,300,000	11.22	55,800,000
September,	1,539,100,000	51,300,000	42,200,000	93,900,000	10.46	46,000,000
October,	1,737,500,000	58,000,000	35,800,000	97,500,000	11.41	46,500,000
November,	1,751,100,000	58,400,000	46,300,000	73,700,000	11.11	61,500,000
December,	2,029,900,000	65,500,000	49,900,000	111,000,000	10.81	59,900,000
Total,	23,535,300,000	-	-	-	-	-
Average,	-	64,600,000	48,900,000	100,700,000	11.15	55,400,000

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (23,535.3 Million Gallons) \times Lift (11.15 Feet) = 262,418.6 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$18,550 61	\$0.07069
Coal,	16,788 97	0.06398
Oil,	275 75	0.00105
Waste,	155 48	0.00059
Water,	1,448 40	0.00552
Packing,	127 31	0.00046
Miscellaneous supplies, repairs and renewals,	1,345 39	0.00513
Totals,	\$38,691 91	\$0.14744
Labor at screens,	\$3,543 86	-

East Boston Pumping Station.

At this station are four submerged centrifugal pumps, with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 73,700,000 foot-pounds.

Average quantity raised each day: 62,600,000 gallons.

Force employed; 4 engineers, 2 relief engineers, 3 firemen, 1 relief fireman, 4 oilers, 3 screenmen, 1 relief screenman, 3 helpers and 1 laborer.

Coal used: Bituminous, costing from \$5.55 to \$10.38 per gross ton, and anthracite screenings, costing \$6.72 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1917.						
January,	1,943,900,000	62,700,000	48,400,000	98,800,000	14.97	76,800,000
February,	1,754,800,000	62,700,000	48,400,000	103,000,000	15.14	79,600,000
March,	2,087,400,000	67,300,000	46,600,000	102,000,000	14.87	76,400,000
April,	2,021,500,000	67,400,000	52,700,000	102,200,000	14.82	82,400,000
May,	2,181,600,000	70,400,000	52,700,000	115,700,000	15.01	75,500,000
June,	2,148,200,000	71,600,000	56,800,000	106,300,000	15.09	74,500,000
July,	1,984,800,000	64,000,000	48,900,000	79,900,000	15.46	89,300,000
August,	1,869,500,000	60,300,000	41,800,000	108,300,000	14.87	67,000,000
September,	1,479,100,000	49,300,000	40,200,000	91,900,000	14.56	60,300,000
October,	1,737,500,000	56,000,000	33,800,000	95,500,000	15.14	63,800,000
November,	1,691,100,000	56,400,000	44,300,000	71,700,000	15.47	69,800,000
December,	1,967,900,000	63,500,000	47,900,000	109,000,000	15.48	68,900,000
Total,	22,867,300,000	-	-	-	-	-
Average,	-	62,600,000	46,900,000	98,700,000	15.07	73,700,000

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (22,867.3 Million Gallons) \times Lift (15.07 feet) = 344,610.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$21,131 14	\$0.06132
Coal,	17,113 92	0.04966
Oil,	631 68	0.00183
Waste,	86 67	0.00025
Water,	1,633 20	0.00474
Packing,	102 99	0.00030
Miscellaneous supplies, repairs and renewals,	2,205 33	0.00640
Totals,	\$42,904 93	\$0.12450
Labor at screens,	\$1,642 50	-

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impeller wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 60,000,000 gallons with 8-foot lift.

Contract capacity of 2 pumps: 22,000,000 gallons each, with 11-foot lift.

Average duty for the year: 53,100,000 foot-pounds.

Average quantity raised each day: 36,300,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing from \$5.75 to \$9.30 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1917.						
January,	1,141,600,000	36,800,000	28,700,000	52,700,000	8.20	51,100,000
February,	1,041,000,000	37,200,000	25,800,000	53,300,000	8.24	50,000,000
March,	1,201,900,000	38,800,000	26,600,000	55,900,000	8.64	57,300,000
April,	1,038,300,000	34,600,000	27,300,000	56,300,000	8.39	49,000,000
May,	1,212,300,000	39,100,000	30,100,000	61,400,000	8.48	53,200,000
June,	1,165,900,000	38,900,000	30,500,000	55,600,000	8.32	51,400,000
July,	995,800,000	32,100,000	24,000,000	41,200,000	8.41	55,900,000
August,	1,146,100,000	37,000,000	23,100,000	55,800,000	8.11	49,300,000
September,	1,057,100,000	35,200,000	22,700,000	63,900,000	8.65	57,100,000
October,	1,061,700,000	34,200,000	21,800,000	52,100,000	8.29	52,300,000
November,	986,900,000	32,900,000	24,000,000	39,100,000	8.25	51,200,000
December,	1,193,200,000	38,500,000	29,100,000	64,600,000	7.91	59,700,000
Total,	13,241,800,000	-	-	-	-	-
Average,	-	36,300,000	26,100,000	54,300,000	8.32	53,100,000

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (13,241.8 Million Gallons) \times Lift (8.32 Feet) = 110,171.8 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$15,033 11	\$0.13645
Coal,	7,190 15	0.06526
Oil,	150 55	0.00136
Waste,	104 71	0.00095
Water,	707 10	0.00642
Packing,	110 99	0.00101
Miscellaneous supplies, repairs and renewals,	153 93	0.00140
Totals,	\$23,450 54	\$0.21285
Labor at screens,	\$3,456 26	-

Alewife Brook Pumping Station.

The plant at this station consists of two 9-inch Andrews commercial centrifugal pumps, direct connected by horizontal shafts to compound marine engines, together with a pump and engine added later. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the 2 original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 15,400,000 foot-pounds.

Average quantity raised each day: 3,393,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing from \$9.75 to \$10.76 per gross ton, and anthracite screenings, costing \$5.70 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1917.						
January,	94,700,000	3,055,000	2,246,000	4,922,000	13.10	15,500,000
February,	87,407,000	3,122,000	2,414,000	6,636,000	18.06	15,900,000
March,	141,737,000	4,572,000	3,229,000	6,400,000	12.98	19,100,000
April,	137,342,000	4,578,000	3,814,000	6,636,000	12.94	18,700,000
May,	146,399,000	4,723,000	3,526,000	7,108,000	12.99	18,300,000
June,	127,279,000	4,243,000	3,574,000	6,141,000	13.00	16,900,000
July,	92,226,000	2,975,000	2,372,000	4,677,000	12.93	15,500,000
August,	83,911,000	2,707,000	2,246,000	4,860,000	13.00	14,700,000
September,	72,916,000	2,430,000	2,078,000	4,922,000	13.03	14,000,000
October,	82,394,000	2,658,000	1,910,000	4,376,000	13.01	12,600,000
November,	81,744,000	2,725,000	2,330,000	4,085,000	13.06	11,800,000
December,	90,811,000	2,929,000	2,414,000	5,494,000	13.08	11,300,000
Total,	1,238,866,000	-	-	-	-	-
Average,	-	3,393,000	2,679,000	5,521,000	13.01	15,400,000

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,238.866 Million Gallons) \times Lift (13.01 Feet) = 16,117.64 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot- gallons.
Labor,	\$6,657 56	\$0.41306
Coal,	4,096 39	0.25416
Oil,	115 41	0.00716
Waste,	77 15	0.00479
Water,	231 00	0.01433
Packing,	32 22	0.00200
Miscellaneous supplies, repairs and renewals,	230 84	0.01432
Totals,	\$11,440 57	\$0.70982
Labor at screens, oiling and miscellaneous services,	\$2,560 00	-

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of 2 pumps: 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 85,846,000 foot-pounds.

Average quantity raised each day: 28,457,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 5 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: Bituminous, costing from \$5.52 to \$10.36 per gross ton.

Material intercepted at screens during the year, 1,521.3 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1917.						
January,	853,331,000	27,527,000	21,260,000	37,312,000	42.07	84,223,000
February,	785,972,000	28,070,000	23,779,000	46,916,000	42.32	90,379,000
March,	1,021,329,000	32,949,000	25,832,000	46,053,000	42.64	88,528,000
April,	994,881,000	33,163,000	30,107,000	42,901,000	42.15	86,506,000
May,	1,096,103,000	35,358,000	29,345,000	47,056,000	41.95	97,613,000
June,	930,312,000	31,010,000	27,126,000	40,259,000	42.45	88,282,000
July,	758,311,000	24,462,000	20,571,000	28,511,000	41.52	77,848,000
August,	787,828,000	25,424,000	19,285,000	34,169,000	41.51	84,494,000
September,	687,343,000	22,911,000	19,649,000	33,946,000	41.48	79,822,000
October,	836,506,000	26,984,000	20,155,000	39,386,000	41.48	83,356,000
November,	803,729,000	26,791,000	22,855,000	32,185,000	41.87	79,935,000
December,	831,686,000	26,829,000	23,675,000	41,133,000	41.38	89,170,000
Total,	10,387,331,000	-	-	-	-	-
Average,	-	28,457,000	23,637,000	39,152,000	41.90	85,846,000

Records from plunger displacements.

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (10,387.3 Million Gallons) \times Lift (41.90 Feet) = 435,229.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$18,652 90	\$0.04286
Coal,	16,719 13	0.03841
Oil,	300 17	0.00069
Waste,	107 43	0.00025
Water,	1,520 40	0.00349
Packing,	524 30	0.00120
Miscellaneous supplies, repairs and renewals,	2,957 93	0.00680
Totals,	\$40,782 26	\$0.09370
Labor at screens,	\$4,563 33	-

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of 3 pumps: Deane, 3,000,000 gallons; Deane, 5,000,000 gallons; Lawrence centrifugal, 10,000,000 gallons.

Average duty for the year: 31,000,000 foot-pounds.

Average quantity raised each day: 4,033,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing \$10.60 per gross ton and anthracite screenings costing \$6.72 per gross ton.

Materials intercepted at screen during the year, 277 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1917.						
January,	109,994,000	3,548,000	2,809,000	4,644,000	21.04	25,900,000
February,	95,195,000	3,400,000	3,054,000	4,627,000	21.04	25,400,000
March,	148,312,000	4,784,000	3,434,000	6,068,000	23.17	30,500,000
April,	159,178,000	5,306,000	4,423,000	7,650,000	25.26	33,100,000
May,	164,153,000	5,295,000	4,084,000	7,155,000	24.61	33,800,000
June,	183,426,000	6,114,000	4,159,000	9,846,000	24.04	34,100,000
July,	125,919,000	4,062,000	3,455,000	4,917,000	25.84	36,300,000
August,	120,691,000	3,893,000	3,053,000	4,928,000	23.46	33,600,000
September,	112,817,000	3,761,000	3,267,000	4,620,000	21.86	30,900,000
October,	118,612,000	3,826,000	3,100,000	6,481,000	21.49	29,100,000
November,	132,321,000	4,410,000	3,613,000	6,078,000	23.81	34,100,000
December,	121,475,000	3,919,000	3,527,000	4,416,000	22.31	26,200,000
Total,	1,592,093,000	-	-	-	-	-
Average,	-	4,033,000	3,498,000	5,953,000	23.16	31,000,000

Average Cost per Million Foot-gallons for pumping at the Quincy Station.

Volume (1,592.1 Million Gallons) \times Lift (23.16 Feet) = 36,873.03 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,380 92	\$0.17305
Coal,	3,786 98	0.10270
Oil,	43 56	0.00118
Waste,	48 99	0.00133
Water,	260 41	0.00706
Packing,	61 77	0.00168
Miscellaneous supplies, repairs and renewals,	265 43	0.00720
Totals,	\$10,848 06	\$0.29420
Labor at screens, oiling and miscellaneous services,	\$2,452 21	-

Nut Island Screen-house.

The plant at this house includes two sets of screens in duplicate actuated by small reversing engines of the Fitchburg type. Two vertical Dean boilers, 80 horse-power each, operate the engines, provide heat and light for the house, burn materials intercepted at the screens, and furnish power for the Quincy (Hough's Neck) sewage lifting station.

Average daily quantity of sewage passing screens, 60,200,000 gallons.

Total materials intercepted at screens, 1,151.6 cubic yards.

Materials intercepted per million gallons of sewage discharged, 1.42 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing from \$6.60 to \$9.31 per gross ton.

Quincy (Hough's Neck) Sewage Lifting Station.

At this station are two 6-inch submerged Lawrence centrifugal pumps with vertical shafts actuated by two Sturtevant direct-current motors.

The labor and electric energy for this station are supplied from the Nut Island screen-house and as used at present it does not materially increase the amount of coal used at the latter station. The effluent is largely ground water.

Contract capacity of 2 pumps: about 1,500,000 gallons each, with 20-foot lift.

Average daily amount pumped: 184,799 gallons.

Average lift: 15.36 feet.

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year.

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton. ¹
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	
New England Coal & Coke Company.	352	-	-	-	-	-	-	\$5 85
New England Coal & Coke Company.	310	-	-	-	-	-	-	5 88
New England Coal & Coke Company.	332	-	-	-	-	-	-	5 90
New England Coal & Coke Company.	348	-	-	-	-	-	-	5 94
Maritime Coaling Company,	1,000	-	-	-	-	-	-	9 60
New England Coal & Coke Company.	-	375	-	-	-	-	-	5 55
New England Coal & Coke Company.	-	1,275	-	-	-	-	-	5 65
New England Coal & Coke Company.	-	343	-	-	-	-	-	5 68
Metropolitan Coal Company,	-	155	-	-	-	-	-	6 72
Maritime Coaling Company,	-	500	-	-	-	-	-	10 38
New England Coal & Coke Company.	-	-	304	-	-	-	-	5 77
New England Coal & Coke Company.	-	-	302	-	-	-	-	5 78
New England Coal & Coke Company.	-	-	299	-	-	-	-	5 80
Coastwise Coal Company,	-	-	298	-	-	-	-	9 30
Riverside Coal Company,	-	-	-	41	-	-	-	5 70
Coleman Bros.,	-	-	-	47	-	-	-	9 75
Locke Coal Company,	-	-	-	50	-	-	-	9 77
J. A. Whittemore's Sons,	-	-	-	2	-	-	-	10 10
Riverside Coal Company,	-	-	-	116	-	-	-	10 20
Locke Coal Company,	-	-	-	29	-	-	-	10 50
Locke Coal Company,	-	-	-	92	-	-	-	10 75
Locke Coal Company,	-	-	-	25	-	-	-	10 76
Staples Coal Company,	-	-	-	-	66	-	-	5 52
Staples Coal Company,	-	-	-	-	79	-	-	5 57
Staples Coal Company,	-	-	-	-	108	-	-	5 58
Staples Coal Company,	-	-	-	-	187	-	-	5 59
Staples Coal Company,	-	-	-	-	122	-	-	5 62
Staples Coal Company,	-	-	-	-	399	-	-	5 63
Staples Coal Company,	-	-	-	-	210	-	-	5 64
Staples Coal Company,	-	-	-	-	80	-	-	5 65
Staples Coal Company,	-	-	-	-	85	-	-	5 67

¹ Includes adjustments for quality.

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year
— Concluded.

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton. ¹
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screening-house.	
Staples Coal Company, . . .	-	-	-	-	97	-	-	\$5 68
Staples Coal Company, . . .	-	-	-	-	87	-	-	5 69
Staples Coal Company, . . .	-	-	-	-	566	-	-	10 33
Metropolitan Coal Company, . . .	-	-	-	-	-	50	-	6 72
Riverside Coal Company, . . .	-	-	-	-	-	205	-	10 60
Gorman-Leonard Coal Company, . . .	-	-	-	-	-	-	248	6 60
New England Coal & Coke Company.	-	-	-	-	-	-	351	9 31
Total, bituminous, . . .	2,312	2,493	1,203	331	2,086	205	599	-
Total screenings, . . .	-	155	-	41	-	50	-	-
Average cost, bituminous, . . .	\$7 47	\$6 58	\$6 65	\$10 29	\$6 90	\$10 60	\$8 19	-
Average cost, screenings, . . .	-	6 72	-	5 70	-	6 72	-	-

¹ Includes adjustments for quality.

METROPOLITAN SEWERAGE OUTFALLS.

The original Deer Island outfall was placed at the approximate elevation of mean low water of Boston Harbor. It consisted of a circular opening 6 feet 3½ inches in diameter and was put in operation in May, 1895.

By Chapter 344 of the Acts of the Year 1914 the Legislature authorized the extension of this outfall to a point where the water is approximately 55 feet deep at mean low water. Considerable delay was experienced in getting the necessary license from the United States Government and work was not started on this extension until July, 1916.

The extension consists of 9-foot lengths of cast-iron pipes varying in diameter from 84 inches to 48 inches at the southerly end. This outer pipe is open at the end and the preceding 13 pipes have openings on the top. Through these 13 openings and through the 48-inch terminal pipe the sewage is discharged. The total length

of the extension is 322 feet. The new outfall was put in operation December 3, 1917.

Examinations have been made to determine the amount of dilution by this method as compared with that obtained by the former method of discharge. Samples of diluted sewage taken at the outfall since December 3, 1917, have been examined by the State Department of Health and have been compared by them with samples taken in repeated examinations of dilution by the former method.

Mr. H. W. Clark, Director and Chief Chemist in the State Department of Health, says:—

For a comparison you can turn to the report of the Metropolitan Sewerage Commissioners upon "A High-level Gravity Sewer for the Relief of the Charles and Neponset River Valleys."¹ You will find on page 111 of that report the results of the analysis of samples collected by us during the investigation of 1898. The surface samples collected at the Deer Island Outfall at that time contained from twenty to ninety times as much free ammonia and from five to thirty-five times as much albuminoid ammonia as shown by the samples brought in by you. Of course, many comparisons could be made of samples taken during more recent years, but these, I think, are sufficient.

Observations have been carried on for only one month but the indications are that the change in method has been successful to a high degree in the matter of dilution and in the improvement of the appearance of the harbor water at the point of discharge.

During construction work on this extension it was necessary to divert the sewage through a temporary outfall. This consists of a 6½ foot concrete sewer leading into one line of 60-inch cast-iron pipe which extends beneath the harbor bed southeasterly from the extreme southerly end of Deer Island to a point where the water is about 3 feet deep at mean low water. It is proposed to leave this temporary outfall in place and at some future time extend it to a point where the water is 40 feet deep at low tide.

The two outfalls thus provided would afford means for such ample dilution that probably no evidences of sewage could easily be found.

The 60-inch outfalls of the South Metropolitan System, two of which were completed in 1904 and the third one in 1915, are in good condition and free from deposit.

During the year the average flow through the North Metro-

¹ 1899.

politan outfall at Deer Island has been 64,600,000 gallons of sewage per 24 hours, with a maximum rate of 161,100,000 gallons during the stormy periods in October and December. The amount of sewage discharged in the North Metropolitan District averaged 114 gallons per day for each person, taking the estimated population of the district contributing sewage. If the sewers in this district were restricted to the admission of sewage proper only, this per capita amount would be considerably decreased.

In the South Metropolitan District an average of 60,200,000 gallons of sewage has passed daily through the screens at the Nut Island screen-house, and has been discharged from the outfalls into the outer harbor. The maximum rate of discharge per day, which occurred during a heavy storm on October 24, was 162,000,000 gallons. The discharge of sewage through these outfalls represents the amount of sewage contributed in the South Metropolitan System, which was at the rate of 176 gallons per day per person of the estimated number contributing sewage in the District.

The daily discharge of sewage per capita is considerably larger in the South Metropolitan District than it is in the North Metropolitan District, because, owing to the large size and unused capacity of the High-level sewer, more storm water is at present admitted to the sewers.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan Sewerage stations, consisting of rags, paper and other floating materials, has during the year amounted to 2,211 cubic yards. This is equivalent to 2.537 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan Sewerage stations has amounted to 2,949.9 cubic yards, equal to 3.62 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers and siphons indicate that they are free from deposit.

FREDERICK D. SMITH,

Chief Engineer of Sewerage Works.

Boston, January 2, 1918.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
1 374 ¹	75 tons special castings,	4	\$5,250 00	\$5,100 00 ²	Standard Cast Iron Pipe & Foundry Co., Bristol, Pa.
2 375 ¹	Venturi meter tubes, registers and parts.	— ³	— ³	— ³	Builders Iron Foundry, Providence, R. I.
3 377 ¹	Water valves: 5 38-inch, 2 30- inch, 4 18-inch and 5 12-inch screw lift valves.	3	8,100 00	6,965 00 ²	Coffin Valve Co., Bos- ton.
4 378 ¹	Check valves: 3 30-inch, 1 20- inch and 1 10-inch check valves.	4	1,535 00	1,527 00 ²	Ludlow Valve Mfg. Co., Troy, N. Y.
5 378-A ¹	Check valves: 2 48-inch and 1 33-inch check valves.	3	3,072 00	2,350 00 ²	Coffin Valve Co., Bos- ton.
6 379 ¹	Street chambers for Venturi meter chambers; 6 cham- bers.	2	2,022 00	1,650 00 ²	Daniel Russell Boiler Works, Boston.
7 332	Centrifugal pumping unit for Northern Extra High Ser- vice pumping station, Arling- ton.	3	10,655 00	9,000 00 ²	F. A. Massur & Co., Boston.
8 333	Horizontal fire-tube boiler for Northern Extra High Ser- vice pumping station, Arling- ton.	3	2,339 00	2,296 00 ²	New England Iron Works Co., Boston.
9 334	500 tons 38-inch cast-iron water pipe; 21 tons special castings.	3 ⁴	32,330 00	31,860 00	- -
10 335	Electric power transmission line between Wachusett power station in Clinton and Sudbury power station in Southborough.	3	79,000 00	74,477 00 ²	Fred T. Ley & Co., Springfield, Mass.
11 33-M	Sale and purchase of electric energy to be developed at Sudbury Dam.	2	— ³	— ³	Edison Electric Illu- minating Co. of Bos- ton.

¹ Contract completed.² Contract based upon this bid.³ Competitive bids were not received.

APPENDIX No. 1.

THE YEAR 1917 — WATER WORKS.

1917 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1917.	
June 19, 1916	Oct. 5, 1917	See previous report,	\$5,304 88	1
June 16, 1916	Apr. 5, 1917	See previous report,	3,395 00	2
July 31, 1916	May 14, 1917	See previous report,	6,965 00	3
Aug. 2, 1916	Mar. 13, 1917	See previous report,	1,527 00	4
July 31, 1916	Apr. 14, 1917	See previous report,	2,350 00	5
Oct. 31, 1916	Mar. 16, 1917	See previous report,	1,650 00	6
Mar. 31, 1917	-	For whole work, \$9,000,	5,500 00	7
May 15, 1917	-	For whole work, \$2,296,	1,800 00	8
-	-	For 36-inch pipes, \$58 and \$59, and for special castings, \$120 per ton of 2,000 pounds.	-	9
July 28, 1917	-	For transmission line with telephone circuit complete, ready for regular operation, \$74,477.	34,442 55	10
Dec. 21, 1914	-	See previous report,	30,692 47	11

⁴ All bids rejected, as appropriation was not sufficient for doing work proposed.

⁵ Contract based upon bid of \$6.25 per M kilowatt hours for entire output. Other bid for portion of output.

CONTRACTS MADE AND PENDING DURING

1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
12	46-M ¹ 1,500 tons anthracite screenings for Chestnut Hill pumping stations.	— ²	— ²	— ²	C. W. Clafin & Co., Boston.
13	47-M ¹ 450 tons bituminous coal for Arlington pumping station and 120 tons for Hyde Park pumping station.	Arlington station, 3. Hyde Park station, 2.	\$4.78 per ton. \$4.50 ² per ton.	\$4.70 ² per ton. \$4.48 per ton.	Garfield & Proctor Coal Co., Boston.
14	49-M ¹ 4,500 tons bituminous coal for Chestnut Hill pumping stations.	3	\$4.33 per ton.	\$4.28 ² per ton.	E. Russell Norton, Boston.
15	50-M ¹ Superstructure of garage at Chestnut Hill Reservoir.	11	8,100 00	8,018 00 ²	Crowley & Hickey, Boston.
16	51-M Sale and purchase of electric energy to be developed at Wachusett Dam in Clinton.	1	—	\$5.30 per M kilowatt hours.	New England Power Co. & Edison Electric Illuminating Co. of Boston.
17	52-M 2,000 tons anthracite screenings for Chestnut Hill pumping station, 240 tons for Arlington pumping station.	Chestnut Hill stations, 2. Arlington station, 2.	\$5.15 per ton, subject to change in freight rate. \$6 per ton, subject to change in freight rate.	\$4.20 ² per ton, subject to change in freight rate. \$4.65 ² per ton, subject to change in freight rate.	Dexter & Carpenter, Inc., Boston.
18	53-M 400 tons anthracite screenings for Spot Pond pumping station.	1	—	\$5.30 ² per ton, subject to change in freight rate.	Locke Coal Co., Malden, Mass.
19	54-M 4,000 tons bituminous coal for Chestnut Hill pumping stations, 400 tons for Arlington pumping station.	Chestnut Hill stations, 2. Arlington station, 1.	\$8.35 per ton, subject to change in freight rate. —	\$7.35 ² per ton, subject to change in freight rate. \$7.80 ² per ton, subject to change in freight rate.	Shaftsbury Coal and Coke Co., Inc., New York, N. Y.
20	55-M 800 tons bituminous coal for Spot Pond pumping station.	2	\$11 per ton, delivered at station.	\$8.70 ² per ton, subject to change in freight rate or in mining wage scale, f. o. b. cars, Melrose.	E. Russell Norton, Boston.

¹ Contract completed.² Contract based upon this bid.

THE YEAR 1917 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1917.	
June 7, 1916	Apr. 9, 1917	See previous report,	\$1,201 00	12
June 9, 1916	July 13, 1917	See previous report,	2,668 96	13
June 15, 1916	June 21, 1917	See previous report,	\$19,117 95	14
Sept. 29, 1916	June 15, 1917	See previous report,	8,029 85	15
Jan. 13, 1917	-	Maximum amount required to be taken, 7 million kilowatt hours per year; contract to continue for 10 years from completion of transmission line being constructed under Contract No. 385.	-	16
June 4, 1917	-	For anthracite screenings delivered on cars at the Chestnut Hill pumping stations, \$4.20 per ton of 2,240 pounds, and on cars at the Arlington pumping station, \$4.65 per ton of 2,240 pounds; price in each case subject to advance in freight rate.	6,020 39	17
June 6, 1917	-	For anthracite screenings delivered in bins at the Spot Pond pumping station, \$5.30 per ton of 2,240 pounds.	1,906 84	18
July 9, 1917	-	For bituminous coal delivered on cars at Chestnut Hill pumping stations, \$7.35 per ton of 2,240 pounds; and on cars at the Arlington pumping station, \$7.80 per ton of 2,240 pounds, price in each case subject to advance in freight rate.	15,020 37	19
May 28, 1917	-	For bituminous coal delivered on cars at the Melrose station on the Boston & Maine Railroad, \$8.70 per ton of 2,240 pounds, subject to advance in freight rate and on basis of mining wage scale in effect May 4, 1917.	5,556 13	20

* Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
21	56-M	Venturi meter tube, register and chart recorder.	- ³	- ³	Builders Iron Foundry, Providence, R. I.
22	57-M	Vertical fire-tube boiler for Clinton Sewerage pumping station.	3 ⁴	\$2,100 00 \$1,950 00	- -
23	58-M ¹	Feed-water heater for Chestnut Hill pumping station.	3	538 00 525 00 ²	Edward P. Brook & Co., Boston.
24	59-M	Ash conveyor for Spot Pond pumping station.	2	1,250 00 609 00 ²	George J. Hagan Co., Boston.
25	60-M ¹	Pelton motor and generator for Spot Pond pumping station.	- ³	- ³	Pelton Water Wheel Co., Inc., New York, N. Y.
26	Agreement.	Sale and purchase of electric energy to be developed at Wachusett Dam after expiration of Contract No. 22-M and until energy is delivered under Contract No. 51-M, which cannot be done until the completion of the transmission line being constructed under Contract No. 385.	- ⁷	- ⁷	New England Power Co., Boston.
27	Special Order. ¹	Plumbing at Sudbury power station, Southborough.	3	214 00 208 00 ²	J. B. Moulton, Framingham, Mass.
28	Special Order. ¹	Valves for use in connection with centrifugal pumping unit for Northern Extra High Service pumping station (Contract No. 382).	3	540 30 439 49 ²	Jenkins Brothers, Boston.

¹ Contract completed.² Contract based upon this bid.³ Competitive bids were not received.⁴ All bids rejected on account of abnormally high prices.

THE YEAR 1917 — WATER WORKS — *Continued.*

7. Date of Con- tract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1917.	
Sept. 26, 1917	-	For a 2-inch extra heavy meter tube having a range of from 1,380 to 17,600 pounds per hour and a Type V. register-indicator recorder, \$725.	\$725 00	21
-	-	-	-	22
Oct. 15, 1917	Nov. 28, 1917	For double-coil Type A, American Standard Feed-water Heater, \$525.	520 21	23
Oct. 19, 1917	-	For Hagan steam jet ash conveyor, \$609.	-	24
June 11, 1917	Oct. 27, 1917	For 18-inch motor with direct connected 2½ kilowatt generator, \$545.	545 00	25
Oct. 1, 1916	-	See previous report,	45,472 25	26
Nov. 28, 1916	Feb. 1, 1917	See previous report,	208 00	27
Aug. 23, 1917	Oct. 10, 1917	For 12 4-inch and 2 3-inch extra heavy iron body, composition mounted Globe valves, \$439.49.	430 70	28

⁷ Agreement made with New England Power Company, with which the Connecticut River Transmission Company, the contractor under Contract No. 22-M, was consolidated.

CONTRACTS MADE AND PENDING DURING THE YEAR 1917 — WATER WORKS —
Concluded.

Summary of Contracts, 1896 to 1917, inclusive.¹

	Value of Work done Dec. 31, 1917.
Distribution Department, 8 contracts,	\$28,491 88
Wachusett Department, 1 contract,	34,442 55
382 contracts completed from 1896 to 1916, inclusive,	17,378,082 63
	\$17,441,017 06
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston,	512,000 00
Total of 391 contracts,	\$16,929,017 06

¹ In this summary contracts charged to maintenance are excluded.

APPENDIX NO. 2.

TABLE NO. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1917.*

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.													
Princeton,	3.15	2.68	3.28	1.89	3.68	4.33	0.84	3.31	1.22	6.18	1.15	1.09	32.80
Jefferson,	3.72	3.91	4.67	1.87	3.75	4.86	1.18	5.29	1.29	6.37	1.39	2.64	40.94
Sterling,	3.24	2.90	4.07	1.65	3.94	4.47	1.37	3.26	1.01	6.29	0.91	2.94	36.05
Boylston,	3.37	2.73	4.81	1.80	4.17	4.23	1.47	5.96	1.28	5.27	1.56	2.58	39.23
Sudbury Dam,	3.20	2.65	4.69	2.26	4.89	4.26	1.04	6.65	1.45	5.41	1.23	2.88	40.61
Framingham,	3.46	2.64	5.20	2.43	4.70	4.28	1.15	6.11	1.50	5.24	1.29	2.79	40.79
Ashland Dam,	3.49	2.64	4.76	2.62	4.70	4.05	1.06	5.74	1.61	5.51	1.26	2.66	40.10
(Cordaville,	3.87	2.77	5.21	2.34	5.43	4.31	1.20	7.10	1.51	6.43	1.47	2.90	44.54
Lake Cochituate,	3.28	2.81	4.82	2.67	4.89	4.33	1.02	5.79	1.77	6.33	1.28	2.70	41.69
Chestnut Hill Reservoir,	3.69	2.68	4.81	3.01	5.32	3.82	1.00	7.50	1.98	6.38	1.08	2.35	43.62
Spot Pond,	3.41	2.56	4.56	3.22	4.72	4.16	1.22	6.33	1.79	5.95	1.10	2.80	41.82
Average of all,	3.45	2.82	4.63	2.34	4.56	4.28	1.41	5.73	1.49	5.94	1.25	2.57	40.20
Average, Wachusett watershed,	3.37	3.05	4.21	1.80	3.89	4.47	1.22	4.46	1.20	6.03	1.25	2.31	37.26
Average, Sudbury watershed,	3.50	2.68	4.96	2.41	4.93	4.23	1.11	6.40	1.52	5.65	1.31	2.81	41.51

TABLE No. 2. — *Rainfall in Inches at Jefferson, Mass., in 1917.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	0.08 ²	-	-	0.68	-	-	-	0.16	-	-	0.65 ¹
2,	-	-	-	-	-	-	-	-	-	-	-	-
3,	0.89 ¹	-	0.08 ²	-	-	-	-	-	-	-	-	-
4,	-	2	2	-	-	-	-	-	-	-	-	-
5,	0.95	1.57 ¹	1.82 ²	-	2	2	-	-	-	2	-	-
6,	-	-	-	-	0.86 ¹	0.27	-	-	0.08	0.50	-	-
7,	-	-	-	0.87 ¹	2	0.16	-	-	-	-	-	-
8,	-	-	0.38	-	2	0.19	-	-	0.28	2	-	0.29 ²
9,	0.12	0.45 ¹	-	0.07 ²	2	-	-	0.07	-	0.21	-	-
10,	-	-	-	-	2	2	-	0.24	-	-	-	-
11,	-	-	0.57 ²	-	2	2	0.75	-	-	0.09	-	-
12,	-	-	-	-	2	1.09	-	-	-	2	-	-
13,	2	-	-	-	0.41 ¹	-	-	0.36	-	0.68	-	2
14,	0.63 ²	-	0.18 ¹	-	-	0.31	-	-	-	-	-	1.65 ¹
15,	-	-	-	-	-	0.63	0.06	-	-	0.23	-	-
16,	-	-	-	-	-	0.96	-	-	-	-	-	-
17,	-	-	0.41 ²	-	-	0.55	-	1.23	2	-	-	-
18,	-	-	-	0.17	-	-	-	-	0.36	0.07	-	-
19,	-	0.24 ¹	-	-	-	-	-	-	-	2	-	-
20,	-	-	-	-	-	-	-	-	-	0.51	-	-
21,	2	-	-	0.24	-	-	-	1.31	-	-	-	-
22,	0.49 ²	0.06 ¹	-	-	2	-	-	-	-	-	0.68 ²	-
23,	-	-	2	-	0.74	-	-	-	-	-	-	-
24,	-	0.41	0.42 ²	-	-	0.31	0.37	0.19	-	1.97	-	-
25,	-	-	-	-	0.17 ¹	-	-	0.11	-	-	-	-
26,	-	2	-	0.13	-	-	-	-	-	-	-	-
27,	2	1.10	0.79 ²	0.30 ¹	-	0.20	-	-	-	2	-	-
28,	2	-	-	-	2	-	-	-	0.12	0.45	0.14 ¹	0.05 ¹
29,	0.36 ¹	-	0.07	-	0.89	0.19	-	2	-	-	-	-
30,	-	-	-	0.09	-	-	-	1.78	0.29	1.66	-	-
31,	0.28 ¹	-	-	-	-	-	-	-	-	-	0.57 ²	-
Totals, . . .	3.72	3.91	4.67	1.87	3.75	4.86	1.18	5.29	1.29	6.37	1.39	2.64

Total for the year, 40.94 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE No. 3. — *Rainfall in Inches at Framingham, Mass., in 1917.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	0.18	-	-	2	-	-	-	0.09	-	-	2
2,	-	-	2	0.01	0.60	0.05	0.04	-	-	-	-	1.02 ²
3,	0.46 ¹	-	0.06 ¹	-	-	-	-	-	-	-	-	-
4,	-	2	0.27 ¹	-	2	-	0.11	-	-	0.01	-	0.02 ¹
5,	0.96	0.84 ¹	2.04 ¹	2	2	0.08	-	-	-	2	-	-
6,	-	-	-	2	1.69	-	-	-	0.02	0.31	-	-
7,	-	-	-	1.12 ¹	-	2	-	-	-	-	-	-
8,	-	-	0.37	2	-	2	-	-	0.20	-	-	0.68 ²
9,	0.05	0.34 ¹	-	0.33 ¹	0.02	0.44	-	0.84	-	2	-	-
10,	-	-	-	-	-	2	-	0.48	-	2	-	-
11,	0.03 ¹	-	2	-	-	2	0.88	-	-	0.25	-	-
12,	-	-	0.56 ¹	0.01	2	1.61	0.02	-	-	2	-	2
13,	2	0.02 ¹	-	0.01	0.24	-	-	-	-	0.48	-	2
14,	0.68	-	2	-	-	-	-	-	-	-	-	1.04 ¹
15,	-	-	0.08 ¹	-	-	0.15	-	-	-	2	-	-
16,	-	-	-	-	-	0.25	-	-	-	0.63	-	-
17,	-	-	0.31 ¹	-	-	1.22	-	1.25	2	-	-	-
18,	-	-	-	0.06	-	-	0.05	-	0.73	0.05	-	-
19,	-	2	-	-	-	-	-	-	-	2	-	-
20,	-	0.24 ²	-	2	-	-	-	-	0.16	0.61	0.02	-
21,	2	-	-	0.45	2	-	-	0.66	-	-	2	-
22,	0.56 ¹	0.04 ¹	-	-	2	-	-	2	-	-	2	-
23,	-	2	2	-	0.66	-	-	2	-	-	0.66	-
24,	-	0.30	0.25	-	-	0.21	-	0.20	-	2	-	2
25,	-	-	-	-	0.01	-	-	0.05	-	2.10	-	0.03 ²
26,	-	2	-	2	-	0.22	-	-	-	-	-	-
27,	2	0.68	1.10	0.42	0.41	-	0.05	-	-	2	-	-
28,	0.07	-	-	-	2	-	-	-	0.16	0.36	0.14 ¹	-
29,	0.08 ¹	-	0.08	2	2	2	-	2	-	-	-	-
30,	-	-	-	0.02	1.07	0.10	-	2.63	0.14	1.04	0.47 ²	-
31,	0.57 ¹	-	0.08	-	-	-	-	-	-	-	-	-
Totals,	3.46	2.64	5.20	2.43	4.70	4.28	1.15	6.11	1.50	5.24	1.29	2.79

Total for the year, 40.79 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE NO. 4. — *Rainfall in Inches at Chestnut Hill Reservoir, 1917.*

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Jan. 3, .	.49 ¹	1.20 P.M. to 9.25 P.M.	May 1, .	.65	9.45 A.M. to 4.25 A.M.
Jan. 5, .	.94	9.30 A.M. to 1.45 A.M.	May 2, .		
Jan. 6, .			May 4, .	1.88	11.55 P.M. to 10.45 A.M.
Jan. 9, .	.14	6.05 P.M. to 9.15 P.M.	May 6, .		
Jan. 11, .	.12 ¹	9.05 A.M. to 2.10 P.M.	May 9, .	.11	5.10 A.M. to 4.15 P.M.
Jan. 14, .	.73 ²	1.40 A.M. to 12.30 P.M.	May 12, .	.39	10.50 A.M. to 3.40 A.M.
Jan. 21, .	.55 ¹	8.35 P.M. to 4.00 A.M.	May 13, .		
Jan. 22, .			May 13, .	.27	6.55 A.M. to 2.00 A.M.
Jan. 27, .	.12 ¹	11.30 P.M. to 7.30 P.M.	May 14, .		
Jan. 28, .			May 22, .	.31	3.45 A.M. to 6.45 P.M.
Jan. 29, .	.10 ¹	5.30 P.M. to 4.00 A.M.	May 23, .	.04	8.30 A.M. to 4.20 P.M.
Jan. 30, .			May 25, .	.35	10.20 A.M. to 8.30 P.M.
Jan. 31, .	.50 ¹	6.50 P.M. to 11.10 P.M.	May 27, .	1.32	11.50 A.M. to 8.15 P.M.
Total,	3.69		May 28, .		
			May 29, .		
			Total,	5.32	
Feb. 1, .	.15 ¹	1.20 A.M. to 10.00 A.M.			
Feb. 4, .	.77 ¹	9.35 P.M. to 6.45 P.M.			
Feb. 5, .					
Feb. 9, .	.40 ¹	7.30 A.M. to 3.30 A.M.			
Feb. 10, .					
Feb. 13, .	.03 ¹	10.30 P.M. to 1.50 A.M.	June 2, .	.09	7.00 A.M. to 7.25 P.M.
Feb. 14, .			June 6, .	.04	12.30 A.M. to 2.45 A.M.
Feb. 19, .	.30 ¹	9.45 P.M. to 3.30 A.M.	June 7, .	.23	6.15 A.M. to 7.30 A.M.
Feb. 20, .			June 9, .	1.24	8.30 A.M. to 7.30 A.M.
Feb. 23, .	.27	8.10 P.M. to 8.45 A.M.	June 10, .		
Feb. 24, .			June 12, .	1.70	6.00 A.M. to 7.35 P.M.
Feb. 25, .	.76	12.30 P.M. to 11.45 P.M.	June 15, .		
Feb. 26, .			June 17, .	.24	2.30 A.M. to 7.30 A.M.
Total,	2.68		June 24, .	.17	11.55 P.M. to 3.15 A.M.
			June 26, .		
			June 27, .	.11	5.40 P.M. to 10.35 P.M.
			June 29, .		
			Total,	3.82	
Mar. 3, .	.07 ¹	12.30 A.M. to 7.00 A.M.			
Mar. 4, .	1.86 ¹	5.45 A.M. to 9.00 P.M.			
Mar. 5, .					
Mar. 8, .	.47	5.20 A.M. to 2.45 P.M.			
Mar. 11, .	.19 ¹	1.50 A.M. to 8.30 A.M.			
Mar. 11, .	.45	8.30 A.M. to 1.55 A.M.			
Mar. 12, .					
Mar. 14, .	.05	4.20 P.M. to 10.30 P.M.	July 2, .	.04	6.20 A.M. to 7.30 A.M.
Mar. 17, .	.29	1.15 P.M. to 9.30 P.M.	July 2, .	.12	9.25 P.M. to 9.50 P.M.
Mar. 23, .	.17	9.45 P.M. to 9.30 A.M.	July 3, .	.11	5.15 P.M. to 4.50 A.M.
Mar. 24, .			July 4, .		
Mar. 27, .	1.07	2.45 P.M. to 2.15 A.M.	July 11, .	.23	12.55 P.M. to 5.15 A.M.
Mar. 28, .			July 12, .		
Mar. 29, .	.09	6.15 A.M. to 1.30 P.M.	July 27, .	.50	3.45 P.M. to 5.30 P.M.
Apr. 1, .	.10	2.45 A.M. to 7.30 A.M.	Total,	1.00	
Total,	4.81				
Apr. 2, .	.04	7.45 P.M. to 11.00 A.M.			
Apr. 3, .					
Apr. 6, .	1.40	2.15 A.M. to 4.55 P.M.	Aug. 9, .	3.70	3.40 A.M. to 10.45 A.M.
Apr. 7, .			Aug. 10, .		
Apr. 9, .	.71 ¹	4.10 A.M. to 1.45 P.M.	Aug. 17, .	.78	8.35 A.M. to 8.30 P.M.
Apr. 18, .	.09	9.50 A.M. to 3.15 P.M.	Aug. 21, .	.39	3.45 P.M. to 1.25 A.M.
Apr. 20, .	.21	6.20 A.M. to 4.45 A.M.	Aug. 22, .		
Apr. 21, .			Aug. 23, .	.28	1.50 A.M. to 8.10 A.M.
Apr. 21, .	.22	6.00 P.M. to 12.30 A.M.	Aug. 24, .		
Apr. 22, .			Aug. 29, .	1.62	6.00 P.M. to 6.30 A.M.
Apr. 26, .	.29	9.30 A.M. to 4.30 A.M.	Aug. 30, .		
Apr. 27, .	.05	8.30 A.M. to 5.30 P.M.	Aug. 30, .	.73	5.15 P.M. to 7.30 P.M.
Total,	3.01		Total,	7.50	

¹ Snow.² Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir, 1917 —*
Concluded.

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Sept. 1, .	.04	11.45 A.M. to 4.15 P.M.	Nov. 21, .	.03	3.00 A.M. to 5.50 A.M.
Sept. 6, .	.04	10.35 A.M. to 12.15 P.M.	Nov. 21, .	.45	7.30 P.M. to 2.30 A.M.
Sept. 8, .	.12	4.00 A.M. to 8.30 A.M.	Nov. 23, .	.04	7.00 P.M. to 9.30 P.M.
Sept. 17, .	1.18	8.00 P.M. to 12.20 P.M.	Nov. 28, .	.21 ¹	7.00 A.M. to 2.30 P.M.
Sept. 18, .	.30	1.50 P.M. to 4.20 P.M.	Nov. 30, .	.35 ²	4.25 P.M. to 7.30 A.M.
Sept. 20, .	.21	4.30 A.M. to 12.30 P.M.	Dec. 1, .		
Sept. 28, .	.09	1.50 P.M. to 8.15 P.M.	Total, .	1.08	
Sept. 30, .					
Total, .	1.98				
Oct. 5, .	.37	7.30 A.M. to 5.45 A.M.	Dec. 1, .	.94 ²	7.30 A.M. to 3.15 A.M.
Oct. 6, .	.16	3.45 P.M. to 10.30 P.M.	Dec. 2, .	.06 ¹	9.15 P.M. to 1.30 A.M.
Oct. 9, .	.25	12.15 A.M. to 5.00 P.M.	Dec. 4, .	.53	8.30 P.M. to 11.00 P.M.
Oct. 11, .	.59	9.40 P.M. to 12.45 A.M.	Dec. 5, .	.05 ¹	7.50 P.M. to 9.30 A.M.
Oct. 12, .	.07	6.50 A.M. to 5.00 P.M.	Dec. 12, .	.69 ²	12.15 A.M. to 6.00 A.M.
Oct. 13, .	.04	5.00 A.M. to 7.30 A.M.	Dec. 13, .	.04 ¹	10.00 P.M. to 9.45 A.M.
Oct. 15, .	.56	9.30 P.M. to 4.40 A.M.	Dec. 14, .		
Oct. 18, .	2.53	5.55 A.M. to 9.00 P.M.	Dec. 16, .	.04 ¹	7.30 A.M. to 10.50 A.M.
Oct. 19, .	.31	9.45 P.M. to 2.50 A.M.	Dec. 17, .		
Oct. 20, .	1.50	11.30 P.M. to 7.30 P.M.	Dec. 28, .		
Oct. 24, .			Total, .	2.35	
Oct. 27, .					
Oct. 28, .					
Oct. 29, .					
Oct. 30, .					
Total, .	6.38				

Total for year, 43.62 inches.

¹ Snow.² Rain and snow.

TABLE No. 5. — *Rainfall in Inches on the Wachusett Watershed,¹ 1897 to 1917.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897.	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.83	0.94	7.62	6.41	51.84
1898.	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899.	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900.	4.56	8.69	6.19	2.76	4.34	3.59	3.30	3.18	3.46	2.90	6.44	3.15	52.46
1901.	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902.	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	49.58
1903.	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904.	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905.	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906.	2.59	2.74	5.17	3.12	6.58	5.95	5.53	4.34	2.61	3.95	2.25	4.26	49.08
1907.	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908.	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909.	3.52	6.10	4.38	5.71	2.65	3.03	4.25	3.59	3.90	1.70	1.68	3.29	44.80
1910.	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.49	4.17	2.34	37.55
1911.	2.91	2.43	3.79	2.22	1.59	2.37	2.53	5.46	3.04	5.24	4.14	3.01	38.73
1912.	2.57	2.42	5.69	4.06	5.76	0.48	2.65	2.89	2.17	2.53	4.02	4.95	40.19
1913.	3.38	2.55	5.58	3.90	3.71	0.90	2.37	3.08	4.44	6.02	2.59	2.73	41.22
1914.	3.40	3.58	4.33	4.91	3.01	2.00	3.92	4.50	0.15	1.88	2.97	3.89	38.54
1915.	6.31	3.32	0.06	1.80	1.67	3.18	8.60	6.90	1.53	3.05	3.12	5.11	44.65
1916.	1.60	5.98	3.23	3.65	3.34	6.57	5.96	1.72	4.21	1.42	3.15	2.81	43.43
1917.	3.37	3.05	4.21	1.80	3.89	4.47	1.22	4.46	1.20	6.03	1.25	2.31	37.26
Totals.	76.79	79.36	86.45	78.05	71.06	78.17	85.99	88.17	71.79	72.88	68.80	85.63	943.14
Average (21 years).	3.65	3.78	4.13	3.72	3.38	3.72	4.09	4.20	3.42	3.47	3.28	4.08	44.91

¹ Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1916, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1917.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.96	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.70	3.93	6.91	1.98	0.81	2.68	4.34	41.42
1880,	3.57	3.96	3.31	3.11	1.64	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	8.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.90	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.63	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	8.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.03	2.77	5.04	4.15	2.30	10.65	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	8.17	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	2.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65

¹ See note at end of this table.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1917* — Concluded.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1901.	1.82	1.52	6.57	9.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902.	2.52	6.18	5.34	4.13	1.96	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903.	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904.	4.37	3.00	2.72	8.87	2.65	2.80	1.96	3.96	5.80	1.64	1.73	2.92	42.82
1905.	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906.	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907.	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908.	3.60	4.56	3.82	1.98	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909.	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.38	4.05	41.75
1910.	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
1911.	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38
1912.	2.94	2.77	6.46	4.37	4.55	0.46	3.24	3.05	1.76	2.35	3.64	5.13	40.72
1913.	3.17	2.82	5.75	4.25	3.97	1.98	3.60	3.64	3.77	5.53	2.65	3.18	44.31
1914.	3.85	4.07	4.57	5.10	3.08	1.90	3.44	3.52	0.29	1.00	2.53	3.46	37.71
1915.	6.51	3.58	0.05	2.48	1.74	3.65	8.12	5.87	1.10	2.95	2.79	5.09	43.93
1916.	1.53	5.91	4.16	4.19	3.43	4.77	5.17	2.01	1.80	1.49	2.28	3.22	39.96
1917.	3.50	2.68	4.96	2.41	4.93	4.23	1.11	6.40	1.52	5.65	1.31	2.81	41.51
Totals.	174.55	177.44	187.64	152.17	142.86	132.89	156.06	168.30	139.71	164.66	157.89	163.60	1,917.77
Average (43 years).	4.06	4.13	4.36	3.54	3.32	3.09	3.63	3.91	3.25	3.83	3.67	3.81	44.60

¹ Means of observations at several places, as follows: January, 1875, to March, 1876, inclusive, Lake Cochituate; April and May, 1876, Lake Cochituate, Westborough and Hopkinton; June to November, 1876, inclusive, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to December, 1882, inclusive, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to December, 1889, inclusive, Framingham and Westborough; January, 1890, to May, 1893, inclusive, Framingham and Ashland Dam; June, 1893, to December, 1916, inclusive, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1917.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,122,000	1,458,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,968,000	2,159,000	2,238,000	2,964,000	1,617,000	2,109,000	1,436,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,194,000	773,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	87,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	810,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	1,382,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	2,540,000
December,	2,275,000	2,061,000	369,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000	1,961,000
Average,	1,263,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000	1,180,000
Average, driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	628,000	413,000	541,000	613,000	725,000

¹ See note at end of this table.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1917* — Concluded.

MONTH.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	Mean for 21 Years, 1897-1917.
January,	1,738,000	592,000	1,846,000	773,000	780,000	1,414,000	990,000	2,062,000	1,315,000	686,000	1,210,000
February,	1,736,000	2,556,000	1,845,000	626,000	927,000	867,000	1,181,000	1,961,000	1,816,000	916,000	1,387,000
March,	2,192,000	2,128,000	2,640,000	1,339,000	2,831,000	2,263,000	3,137,000	872,000	1,891,000	2,472,000	2,548,000
April,	1,269,000	2,422,000	1,034,000	1,393,000	2,281,000	2,083,000	2,593,000	926,000	3,300,000	1,468,000	2,139,000
May,	1,415,000	1,212,000	608,000	461,000	1,797,000	1,038,000	1,698,000	455,000	1,697,000	1,317,000	1,203,000
June,	408,000	632,000	824,000	351,000	331,000	280,000	317,000	228,000	2,054,000	1,229,000	790,000
July,	220,000	233,000	62,000	57,000	135,000	19,000	328,000	1,083,000	1,086,000	264,000	436,000
August,	443,000	193,000	186,000	188,000	125,000	60,000	261,000	1,657,000	294,000	309,000	428,000
September,	88,000	208,000	145,000	181,000	89,000	219,000	—12,000	158,000	294,000	84,000	316,000
October,	153,000	90,000	68,000	718,000	145,000	678,000	136,000	387,000	140,000	555,000	489,000
November,	125,000	363,000	354,000	1,035,000	442,000	660,000	211,000	498,000	321,000	313,000	711,000
December,	387,000	537,000	391,000	1,067,000	793,000	965,000	372,000	1,359,000	460,000	389,000	1,106,000
Average,	847,000	918,000	828,000	682,000	891,000	879,000	934,000	942,000	1,215,000	894,000	1,062,000
Average, driest six months, .	238,000	270,000	201,000	327,000	210,000	318,000	208,000	666,000	432,000	320,000	527,000

¹ The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902 inclusive, 2.4 per cent. in 1903, 3.6 per cent. in 1904, 4.1 per cent. in 1905, 5.1 per cent. in 1906, 6.0 per cent. in 1907, 7.0 per cent. in 1908, 1909 and 1910, 6.5 per cent. in 1911, 6.8 per cent. in 1912, 6.9 per cent. in 1913, 7.4 per cent. in 1914 and 1915, 7.6 per cent. in 1916, 7.4 per cent. in 1917.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1917.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January,	102,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	887,000	1,350,000	2,853,000	1,815,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,356,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	436,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000
August,	396,000	405,000	121,000	476,000	386,000	119,000	148,000	55,000	79,000	257,000	240,000
September,	207,000	194,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000
Average,	972,000	1,136,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000
Average, driest six months, . .	574,000	394,000	502,000	532,000	220,000	143,000	330,000	211,000	145,000	200,000	391,000

¹ See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1917* — Continued.

MONTH.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
January,	1,401,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	663,000	1,034,000	1,084,000
February,	4,801,000	2,829,000	1,950,000	1,106,000	1,529,000	3,496,000	943,000	1,542,000	991,000	541,000	2,676,000
March,	2,059,000	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000
April,	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000
May,	720,000	1,009,000	1,632,000	890,000	1,366,000	583,000	1,239,000	2,883,000	840,000	636,000	360,000
June,	203,000	413,000	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000
July,	116,000	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000
August,	94,000	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000
September,	117,000	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000
October,	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000
November,	673,000	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	669,000
December,	1,020,000	643,000	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000	1,782,000	667,000
Average,	1,087,000	1,154,000	1,697,000	1,385,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000
Average, driest six months,	223,000	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000

¹ See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1917* — Continued.

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
January,	845,000	1,638,000	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000
February,	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000
March,	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000
April,	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,940,000	1,607,000
May,	915,000	1,246,000	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000
June,	962,000	530,000	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000
July,	658,000	231,000	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	9,000
August,	591,000	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000
September,	182,000	369,000	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000
October,	94,000	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	168,000	301,000	741,000
November,	909,000	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000
December,	1,584,000	1,799,000	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000
Average,	991,000	1,450,000	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000
Average, driest six months,	564,000	777,000	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	471,000

¹ See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1917 — Concluded.*

MONTH.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	Mean for 43 Years, 1875-1917.
January,	1,925,000	392,000	1,490,000	519,000	728,000	1,041,000	908,000	1,629,000	942,000	510,000	1,174,000
February,	1,536,000	2,286,000	1,849,000	700,000	1,197,000	764,000	1,009,000	1,870,000	1,356,000	755,000	1,655,000
March,	2,257,000	1,734,000	1,854,000	1,144,000	3,092,000	2,090,000	3,029,000	593,000	1,820,000	2,209,000	2,698,000
April,	1,117,000	1,721,000	667,000	1,426,000	2,235,000	2,232,000	2,353,000	590,000	3,037,000	1,405,000	1,987,000
May,	1,046,000	1,004,000	277,000	318,000	1,447,000	867,000	1,550,000	255,000	1,439,000	1,476,000	1,073,000
June,	194,000	238,000	516,000	213,000	148,000	149,000	5,000	101,000	1,198,000	1,044,000	498,000
July,	—14,000	—121,000	—102,000	—14,000	—77,000	—62,000	107,000	1,045,000	585,000	43,000	181,000
August,	102,000	—45,000	—73,000	20,000	—29,000	—54,000	156,000	1,168,000	78,000	202,000	243,000
September,	—82,000	148,000	5,000	76,000	—28,000	88,000	—135,000	38,000	26,000	58,000	213,000
October,	47,000	—51,000	—51,000	296,000	—14,000	484,000	—59,000	231,000	—5,000	482,000	413,000
November,	71,000	82,000	176,000	593,000	165,000	480,000	97,000	261,000	110,000	438,000	728,000
December,	136,000	263,000	221,000	908,000	494,000	732,000	250,000	898,000	315,000	380,000	945,000
Average,	694,000	625,000	570,000	514,000	779,000	733,000	772,000	719,000	904,000	750,000	980,000
Average, driest six months, . .	44,000	40,000	29,000	151,000	26,000	180,000	29,000	480,000	186,000	267,000	377,000

¹ The area of the Sudbury watershed used in these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs, to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

TABLE No. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1917.*

[Watershed above dam = 108.84 square miles.]

MONTH.	GALLONS PER DAY.							Rainfall collected (Inches).	Rainfall collected (Inches).	Percent- age of Rainfall collected.
	Received from City of Worcester Watershed.	Discharged into Wachusett Aqueduct. ¹	Wasted into River below Dam.	Seepage through the North Dike.	STORAGE. ²		Total Yield of Watershed.			
					Gain.	Loss.				
January,	-	103,062,000	3,729,000	874,000	-	32,981,000	74,684,000	3.37	1.224	36.3
February,	-	99,039,000	3,629,000	850,000	-	3,775,000	99,743,000	3.05	1.476	48.3
March,	9,674,000	26,516,000	2,953,000	890,000	243,329,000	-	269,019,000	4.21	4.409	104.8
April,	11,137,000	82,640,000	3,107,000	967,000	84,230,000	-	159,807,000	1.80	2.535	140.6
May,	15,555,000	86,497,000	12,151,000	1,000,000	59,278,000	-	143,371,000	3.89	2.350	60.5
June,	10,033,000	107,393,000	39,417,000	1,000,000	-	3,967,000	133,810,000	4.47	2.122	47.4
July,	-	108,645,000	4,107,000	1,000,000	-	84,994,000	28,768,000	1.22	0.471	38.8
August,	-	112,261,000	4,226,000	965,000	-	83,791,000	33,661,000	4.46	0.552	12.4
September,	-	103,153,000	4,197,000	937,000	-	99,190,000	9,097,000	1.20	0.144	12.0
October,	-	98,629,000	4,042,000	900,000	-	44,090,000	60,381,000	6.03	0.990	16.4
November,	-	45,100,000	4,460,000	900,000	-	16,417,000	34,043,000	1.25	0.540	43.1
December,	-	108,655,000	4,516,000	877,000	-	71,713,000	42,335,000	2.31	0.694	31.0
Total,	-	-	-	-	-	-	-	37.26	17.507	-
Average for year,	3,883,000	90,121,000	7,598,000	930,000	-	4,041,000	90,723,000	-	-	47.0

¹ Including 187,000 gallons per day drawn from aqueduct for the supply of the Westborough State Hospital.
² Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE No. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1917.*

[Watershed from 1875 to 1878 inclusive=77,764 square miles; in 1879 and 1880=78,238 square miles; and from 1881 to 1917 inclusive=75.2 square miles.]

MONTH.	GALLONS PER DAY.										Rain-fall col- lected (In- ches).	Rain- fall col- lected (In- ches).	Percent- age of Rain- fall col- lected.
	Water received from Wachusett Reservoir. ¹	Water discharged through Sudbury Aqueduct.	Water discharged through Weston Aqueduct.	Water used by Fram- ingham Works.	Water di- verted from Watershed by Sewers, etc.	Water wasted into River below Lowest Dam.	STORAGE.		Total Yield of Water- shed.				
							Gain.	Loss.					
January, .	102,906,000	60,816,000	55,545,000	1,058,000	932,000	25,710,000	-	2,326,000	38,329,000	3.50	0.909	25.9	
February, .	98,882,000	65,472,000	53,021,000	1,157,000	954,000	25,539,000	9,493,000	-	56,754,000	2.68	1.216	45.5	
March, .	26,348,000	53,048,000	52,977,000	1,036,000	1,623,000	96,339,000	-	12,594,000	166,081,000	4.96	3.940	79.4	
April, .	82,483,000	47,170,000	51,553,000	837,000	1,703,000	60,980,000	25,590,000	-	105,650,000	2.41	2.425	100.5	
May, .	86,342,000	47,468,000	52,594,000	842,000	1,645,000	87,568,000	7,271,000	-	110,981,000	4.93	2.632	53.4	
June, .	107,237,000	47,463,000	55,473,000	890,000	1,650,000	62,947,000	17,307,000	-	78,493,000	4.23	1.802	42.7	
July, .	108,478,000	67,439,000	46,681,000	1,071,000	761,000	6,952,000	-	11,216,000	3,210,000	1.11	0.076	6.8	
August, .	112,090,000	64,858,000	47,616,000	1,223,000	658,000	5,787,000	7,188,000	-	15,210,000	6.40	0.361	5.6	
September, .	103,000,000	53,053,000	49,397,000	1,203,000	847,000	7,913,000	-	5,063,000	4,360,000	1.52	0.100	6.6	
October, .	98,481,000	51,865,000	53,277,000	1,155,000	823,000	18,174,000	9,439,000	-	36,252,000	5.65	0.860	15.2	
November, .	44,957,000	47,240,000	53,337,000	1,163,000	883,000	30,654,000	-	55,350,000	32,970,000	1.31	0.757	57.6	
December, .	108,497,000	60,822,000	53,323,000	1,194,000	958,000	24,213,000	-	3,410,000	28,603,000	2.81	0.678	24.2	
Total, .	-	-	-	-	-	-	-	-	-	41.51	15.756	-	
Av. for year, .	89,963,000	55,553,000	52,079,000	1,069,000	1,119,000	37,794,000	-	1,236,000	56,415,000	-	-	38.0	

¹ Not including 157,000 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough State Hospital, which were not discharged into Sudbury Reservoir.

TABLE No. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1917.*
 [Watershed of lake=17.58 square miles. ¹]

MONTH.	GALLONS PER DAY.						Rainfall collected (Inches).	Rainfall collected (Inches).	Percent- age of Rainfall collected.
	Water discharged through Cochituate Aqueduct.	Water di- verted from Watershed by Sewers, etc.	Water wasted at Outlet of Lake.	STORAGE.		Total Yield of Watershed.			
				Gain.	Loss.				
January,	-	532,000	10,613,000	-	2,465,000	8,681,000	3.28	0.88	26.9
February,	-	525,000	15,721,000	-	2,214,000	14,032,000	2.81	1.29	45.8
March,	-	1,129,000	39,516,000	-	5,458,000	35,187,000	4.82	3.57	74.1
April,	-	1,643,000	8,210,000	12,740,000	-	22,593,000	2.67	2.22	83.1
May,	-	1,720,000	21,584,000	1,519,000	-	24,823,000	4.89	2.52	51.5
June,	-	1,513,000	16,334,000	1,343,000	-	19,190,000	4.33	1.88	43.5
July,	-	636,000	2,561,000	-	155,000	3,042,000	1.02	0.31	30.3
August,	1,042,000	400,000	1,226,000	1,222,000	-	3,890,000	5.79	0.39	6.8
September,	3,103,000	327,000	1,643,000	-	3,466,000	1,607,000	1.77	0.16	8.9
October,	-	413,000	8,364,000	2,897,000	-	11,674,000	6.33	1.18	18.7
November,	-	673,000	17,150,000	-	8,483,000	9,340,000	1.28	0.92	71.7
December,	-	471,000	21,394,000	-	10,155,000	11,710,000	2.70	1.19	44.0
Total,	-	-	-	-	-	-	41.69	16.51	-
Average for year,	344,000	833,000	13,708,000	-	790,000	14,093,000	-	-	39.6

¹ Not including the watersheds of Dudley and Dug ponds.

TABLE No. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir. Ordinary High Water = 134.00.	Lake Cochituate. High Water = 144.36.	Farm Pond. High Water = 159.25.	Spot Pond. High Water = 163.00.	Weston Reservoir. High Water = 200.00.	FRAMINGHAM RESERVOIR.			Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water = 337.91.	Wachusett Reservoir. Ordinary High Water = 395.00.
						No. 1. Flash Boards 169.32.	No. 2. Flash Boards 177.12.	No. 3. Flash Boards 186.50.					
Jan. 1, 1917, .	133.24	143.23	157.39	162.41	197.57	167.70	176.02	183.53	224.28	258.49	304.07	336.65	387.11
Feb. 1, 1917, .	133.78	142.85	158.06	162.69	199.67	163.85	176.05	184.19	224.38	258.57	304.11	336.22	386.25
Mar. 1, 1917, .	133.39	142.54	158.12	162.53	199.84	168.11	176.44	184.48	223.91	258.90	303.38	336.24	385.95
Apr. 1, 1917, .	133.56	141.72	158.38	162.90	199.92	168.11	176.43	182.84	223.74	258.11	302.98	336.71	391.92
May 1, 1917, .	133.34	143.57	158.29	162.90	198.57	166.71	176.15	184.41	225.19	258.97	305.04	337.50	393.96
June 1, 1917, .	133.54	143.77	158.37	163.04	198.36	167.63	177.48	184.33	225.23	259.18	304.99	337.74	396.36
July 1, 1917, .	132.95	143.94	158.34	162.33	200.21	169.48	177.31	186.46	225.23	259.81	305.01	337.78	396.31
Aug. 1, 1917, .	132.73	143.92	157.91	162.65	199.45	169.30	177.11	185.22	225.17	259.43	304.85	337.60	393.53
Sept. 1, 1917, .	133.39	144.08	157.86	163.12	199.84	169.51	177.34	186.32	225.24	259.61	305.06	337.72	391.61
Oct. 1, 1917, .	133.32	143.64	157.55	162.99	197.99	169.36	177.20	185.45	225.21	259.57	304.92	337.59	389.41
Nov. 1, 1917, .	133.41	144.02	157.78	163.30	199.32	169.58	177.53	185.87	225.17	259.94	304.99	337.92	388.10
Dec. 1, 1917, .	133.63	142.86	157.62	162.95	198.76	167.74	176.10	184.45	224.32	258.88	304.13	337.63	387.70
Jan. 1, 1918, .	132.52	141.91	157.75	162.05	198.41	167.71	176.02	183.25	223.59	257.52	303.30	336.79	385.94

TABLE No. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.**From Wachusett Reservoir into the Wachusett Aqueduct.*

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	26	258	45	3,194.9
February,	23	218	25	2,773.1
March,	25	223	5	822.0
April,	24	220	12	2,479.2
May,	26	232	11	2,681.4
June,	27	272	55	3,221.8
July,	25	236	57	3,368.0
August,	27	274	49	3,480.1
September,	24	220	10	3,094.6
October,	26	243	37	3,057.5
November,	23	200	48	1,353.0
December,	26	250	50	3,368.3
Totals,	302	2,852	44	32,893.9

Total actual time, 118.86 days.

Total quantity drawn, 32,893,900,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to Weston Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	26	351	22	1,721.9
February,	23	307	30	1,484.6
March,	27	368	58	1,642.3
April,	24	366	05	1,555.6
May,	26	398	45	1,630.4
June,	26	392	35	1,664.2
July,	25	363	45	1,447.1
August,	27	383	14	1,476.1
September,	24	371	40	1,481.9
October,	26	393	04	1,651.6
November,	25	380	—	1,600.1
December,	25	382	16	1,653.0
Totals,	304	4,459	14	19,008.0

Total actual time, 185.80 days.

Total quantity drawn, 19,008,800,000 gallons.

TABLE No. 13 — *Concluded.**From Framingham Reservoir No. 3 through the Sudbury Aqueduct to Chestnut Hill Reservoir.*

MONTH.	Number of Days during which Water was flowing.	Actual Time (Hours).	Million Gallons drawn.
January,	31	734.5	1,885.3
February,	28	672	1,833.2
March,	31	744	1,644.5
April,	30	720	1,415.1
May,	31	744	1,471.5
June,	30	720	1,423.9
July,	31	744	2,090.6
August,	31	744	2,010.6
September,	30	720	1,591.6
October,	31	744	1,607.8
November,	30	720	1,417.2
December,	31	744	1,885.5
Totals,	365	8,750.5	20,276.8

Total actual time, 364.60.

Total quantity drawn, 20,276,800,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1917 by Months.*¹

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	102,906,000	55,545,000	60,816,000	—
February,	98,882,000	53,021,000	65,472,000	—
March,	26,348,000	52,977,000	53,048,000	—
April,	82,483,000	51,853,000	47,170,000	—
May,	86,342,000	52,594,000	47,468,000	—
June,	107,237,000	55,473,000	47,463,000	—
July,	108,478,000	46,681,000	67,439,000	—
August,	112,090,000	47,616,000	64,558,000	1,042,000
September,	103,000,000	49,397,000	53,053,000	3,103,000
October,	98,481,000	53,277,000	51,865,000	—
November,	44,957,000	53,337,000	47,240,000	—
December,	108,497,000	53,323,000	60,822,000	—
Average,	89,963,000	52,079,000	55,553,000	344,000

¹ Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill Pumping Station No. 1 for the Year 1917.

MONTH.	ENGINE No. 1.		ENGINE No. 2.		Total Quantity pumped, 3 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal used in Pumping, 3 Per Cent. allowed for Slip.	AVERAGE LEAK (Feet).		Duty in Root-pounds per 100 Pounds of Coal used in Pumping, 3 Per Cent. allowed for Slip.	Duty in Root-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.
	Total Pumping Time.	Quantity pumped, 3 Per Cent. allowed for Slip (Million Gallons).	Total Pumping Time.	Quantity pumped, 3 Per Cent. allowed for Slip (Million Gallons).							Engine No. 1.	Engine No. 2.		
January,	Hrs. Min.	-	-	146.30	337,935	-	28,690	8.5	432.92	-	132.83	47,900,000	49,390,000	
February,	-	-	200 35	65.20	138,820	59,242	17,370	8.8	469.67	-	133.10	52,070,000	53,690,000	
March,	-	-	302 50	94.11	229,225	12,658	25,770	10.7	410.56	-	133.37	45,610,000	47,030,000	
April,	-	-	188 15	62.27	110,440	52,346	17,042	10.5	563.84	-	133.93	62,900,000	64,860,000	
May,	-	-	156 50	53.51	102,635	53,462	17,430	11.2	521.36	-	133.84	58,130,000	59,940,000	
June,	-	-	224 00	78.39	148,310	32,620	26,350	14.6	528.56	-	133.84	58,930,000	60,760,000	
July,	-	-	242 15	89.03	154,505	26,685	26,380	14.6	576.23	-	134.35	64,490,000	66,500,000	
August,	-	-	301 10	107.09	182,970	27,257	28,250	13.4	585.29	-	133.21	64,950,000	66,970,000	
September,	138 55	51.29	88 55	32.33	83.62	179,980	28,175	37,624	18.1	464.61	133.11	132.96	51,500,000	53,100,000
October,	215 30	77.77	-	-	77.77	167,789	41,180	39,374	18.8	463.50	133.94	-	51,710,000	53,320,000
November,	228 50	77.06	-	-	77.06	162,801	20,241	29,019	15.9	473.34	133.61	-	52,680,000	54,320,000
December,	231 15	81.67	-	-	81.67	158,133	95,859	45,165	17.8	516.46	133.40	-	57,390,000	59,170,000
Total,	814 30	287.79	728.23	1,016.02	2,073,543	449,725	338,464	-	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	13.4	489.99	133.55	133.45	-	54,480,000	56,170,000

TABLE No. 16. — Statement of Operation of Engine No. 3 at Chestnut Hill Pumping Station No. 1 for the Year 1917.

MONTH.	Total Pumping Time.		Quantity pumped, 4.4 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in Pumping and Bunking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 4.4 Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Root-pounds, per 100 Pounds of Coal, 4.4 Per Cent. allowed for Slip; no Deduction for Heating or Lighting.	Duty in Root-pounds, per 100 Pounds of Coal, on Basis of Plunger Displacement; No Deduction for Heating or Lighting.
	Hrs.	Min.								
January,
February,
March,
April,
May,
June,
July,
August,
September,
October,
November,
December,
Total,	14	05	10.02	20,014	3,185	17.8	472.21	115.61	45,480,000	47,570,000
Average,	15.9	500.65	116.85	48,650,000	50,880,000

TABLE No. 17. — Statement of Operation of Engine No. 4 at Chestnut Hill Pumping Station No. 1 and Summary for the Station for the Year 1917.

MONTH.	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in Pumping, No Banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 2 Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Root-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Duty in Root-pounds per 100 Pounds of Coal, Displacement; No Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 1, 2, 3 AND 4.	
										Total Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Daily Average Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).
January,	Hrs. Min. 744 00	990.82	643,370	73,140	11.4	1,540.05	120.20	154,200,000	157,300,000	1,137.12	38.681
February,	78 10	103.45	68,360	6,560	9.6	1,513.31	121.05	152,590,000	155,660,000	168.65	6.023
March,	673 20	889.79	585,220	64,360	11.0	1,520.44	120.15	152,170,000	155,230,000	986.75	31.831
April,	"	"	"	"	"	"	"	"	"	62.27	2.076
May,	"	"	"	"	"	"	"	"	"	53.51	1.726
June,	"	"	"	"	"	"	"	"	"	78.39	2.613
July,	"	"	"	"	"	"	"	"	"	89.03	2.872
August,	143 50	187.71	182,760	23,485	12.8	1,026.97	120.82	103,360,000	105,440,000	294.80	9.510
September,	"	"	"	"	"	"	"	"	"	83.62	2.787
October,	"	"	"	"	"	"	"	"	"	77.77	2.509
November,	479 45	637.80	495,750	84,615	17.1	1,286.54	120.61	129,260,000	131,860,000	714.86	23.829
December,	13 15	14.55	17,170	3,000	17.5	847.41	122.51	86,480,000	88,220,000	103.39	3.335
Total,	2,132 20	2,824.12	1,992,650	255,160	-	-	-	-	-	3,850.16	-
Average,	"	"	"	"	12.8	1,417.27	120.36	142,100,000	144,960,000	-	10.548

TABLE No. 18. — Statement of Operation of Engines Nos. 5, 6 and 7 at Chestnut Hill Pumping Station No. 2 for the Year 1917.

MONTH.	ENGINE No. 5.		ENGINE No. 6.		ENGINE No. 7.		Total Quantity pumped, 2 Per Cent. allowed for Ship (Million Gallons).	Daily Average Quantity pumped (Million Gallons).	Total Coal consumed in pumping and banking (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Cent. allowed for Ship, 2 Per Cent. Deduction for Heating or Lighting.	AVERAGE LIFE (FEET).			Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement; No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Ship, No Deduction for Heating or Lighting.
	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Ship (Million Gallons).	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Ship (Million Gallons).	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Ship (Million Gallons).						Engine No. 5.	Engine No. 6.	Engine No. 7.		
January, . . .	Hrs. Min.	-	Hrs. Min.	-	Hrs. Min.	739 22	23 846	324,890	10.7	2,275.29	-	-	33.38	63,270,000	64,570,000	
February, . . .	-	-	160 00	141.82	644 00	649 27	28 253	325,760	15.0	2,428.44	34.74	33.39	33.39	68,030,000	69,420,000	
March, . . .	-	-	278 50	300.36	281 55	287 43	18 967	317,320	14.3	1,852.99	33.47	33.32	33.32	51,550,000	52,610,000	
April, . . .	-	-	-	-	429 15	382 28	12 743	230,070	17.4	1,661.58	-	-	33.54	46,420,000	47,370,000	
May, . . .	-	-	-	-	457 10	411 87	13 286	197,260	16.1	2,087.95	-	-	33.81	58,800,000	60,010,000	
June, . . .	-	-	-	-	520 00	385 82	12 861	201,975	18.0	1,910.24	-	-	33.50	53,310,000	54,400,000	
July, . . .	-	-	36 25	39.52	744 00	813.13	27 505	300,900	14.1	2,833.67	35.83	33.88	33.88	80,190,000	81,830,000	
August, . . .	75 40	81.36	392 15	402.70	334 15	349 09	26 876	393,125	20.5	2,119.30	33.60	34.21	33.32	59,630,000	60,850,000	
September, . . .	58 00	59.52	418 15	448.41	51 35	54.23	18 739	415,025	21.9	1,352.57	32.79	32.90	33.60	37,130,000	37,890,000	
October, . . .	7 50	6.40	453 50	473.07	-	-	15 467	440,260	20.9	1,089.06	32.73	32.56	-	29,540,000	30,150,000	
November, . . .	61 00	55.50	300 55	299.01	-	-	11 817	314,945	23.8	1,128.85	34.19	33.59	-	31,670,000	32,320,000	
December, . . .	15 35	13.33	538 00	620.43	-	-	20 444	393,580	24.5	1,616.92	36.18	30.49	-	41,080,000	41,920,000	
Total, . . .	218 05	216.11	2,578 30	2,725.32	4,124 40	4,072.54	7,013.97	3,854,610	-	-	-	-	-	-	-	-
Average, . . .	-	-	-	-	-	-	19 216	-	18.5	1,819.63	33.66	32.76	33.54	50,390,000	51,420,000	

TABLE No. 21. — Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1917.

MONTH.	Total Pumping Time.		Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped, per Pound of Coal, 2 Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, Displacement; No Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 8 and 9.	
	Hrs.	Min.									Total Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Daily Average Quantity pumped (Million Gallons).
January,	257	15	214.72	206,648	28,845	14.0	1,039.06	129.73	112,290,000	114,570,000	214.72	6.926
February,	251	20	209.50	194,000	26,842	13.3	1,079.90	130.01	116,950,000	119,320,000	209.50	7.483
March,	265	40	222.32	204,463	27,680	13.5	1,087.34	128.95	116,800,000	119,170,000	222.32	7.172
April,	255	10	212.64	197,626	26,485	13.4	1,076.99	129.19	115,900,000	118,250,000	212.64	7.065
May,	256	00	215.83	198,771	24,185	12.2	1,085.82	129.83	117,430,000	119,810,000	221.09	7.132
June,	275	00	230.80	230,870	38,294	16.6	999.70	130.67	108,820,000	110,030,000	230.80	7.693
July,	332	20	281.92	299,239	66,657	22.3	942.12	130.01	102,030,000	104,100,000	281.92	9.094
August,	336	25	284.92	296,333	53,124	17.9	961.49	130.09	104,190,000	106,310,000	284.92	9.191
September,	217	00	182.83	200,311	37,500	18.7	912.73	131.61	100,060,000	102,060,000	246.41	8.214
October,	283	25	236.07	261,923	44,945	17.2	901.30	131.03	98,380,000	100,380,000	236.07	7.615
November,	264	45	210.78	232,956	33,745	14.5	904.81	131.26	98,930,000	100,940,000	210.78	7.026
December,	276	05	231.19	271,105	40,875	15.1	852.77	131.56	93,450,000	95,350,000	231.19	7.468
Total,	3,260	25	2,733.72	2,794,244	448,177	-	-	-	106,200,000	108,260,000	2,802.56	-
Average,	-	-	-	-	-	16.0	978.34	130.31	106,200,000	108,260,000	-	7.678

TABLE No. 22. — Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1917.

MONTH.	Total Pumping Time.		Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Round of Coal, 2 Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Root-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Heating or Lighting; No Deduction for Heating or Lighting.	Duty in Root-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Heating or Lighting; No Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	434	00	20.37	93,890	11,250	12.0	216.96	281.40	50,860,000	51,740,000
February,	488	45	23.63	95,860	15,142	15.8	246.51	281.96	57,900,000	58,900,000
March,	505	00	23.67	93,720	18,307	19.5	252.56	281.96	59,320,000	60,350,000
April,	468	15	21.75	85,955	14,349	16.7	253.04	281.86	59,410,000	60,440,000
May,	507	30	23.66	95,195	17,847	18.7	248.54	281.70	58,320,000	59,330,000
June,	522	30	24.53	101,090	23,768	23.5	242.65	282.66	57,130,000	58,120,000
July,	632	45	33.72	132,285	25,922	19.6	254.90	287.16	60,970,000	62,020,000
August,	594	45	30.91	119,810	23,862	19.9	257.99	285.78	61,420,000	62,480,000
September,	525	00	26.73	96,400	12,719	13.2	277.28	281.21	64,950,000	66,070,000
October,	537	15	26.24	101,295	15,253	15.1	259.05	278.63	60,130,000	61,170,000
November,	512	00	24.43	97,330	17,463	17.9	251.00	280.67	58,690,000	59,700,000
December,	545	00	25.77	112,200	16,894	15.0	229.68	281.65	53,890,000	54,820,000
Total,	6,272	45	305.41	1,225,030	212,766	-	-	-	-	-
Average,	-	-	-	-	-	17.4	249.31	282.43	58,650,000	59,660,000

TABLE No. 23. — Statement of Operation of Engine No. 11 at Arlington Pumping Station for the Year 1917.

MONTH.	Total Pumping Time.		Quantity pumped, & Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, & Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, & Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement; No Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 10 AND 11.	
	Hrs.	Min.									Total Quantity pumped, & Per Cent. allowed for Slip (Million Gallons).	Daily Average Quantity pumped, & Per Cent. allowed for Slip (Million Gallons).
January, .	123	00	4.23	33,195	3,441	10.4	127.43	276.92	29,390,000	30,760,000	24.60	.794
February, .	-	-	-	-	-	-	-	-	-	-	23.63	.844
March, .	-	-	-	-	-	-	-	-	-	-	23.67	.764
April, .	-	-	-	-	-	-	-	-	-	-	21.75	.725
May, .	-	-	-	-	-	-	-	-	-	-	23.66	.763
June, .	-	30	.03	190	-	-	-	-	-	-	24.56	.819
July, .	24	30	.95	6,255	1,210	19.3	151.88	308.58	39,040,000	40,860,000	34.67	1.118
August, .	.76	45	2.61	16,290	3,259	20.0	160.22	303.66	40,530,000	42,410,000	33.52	1.061
September, .	-	-	-	-	-	-	-	-	-	-	26.73	.891
October, .	-	-	-	-	-	-	-	-	-	-	26.24	.846
November, .	-	-	-	-	-	-	-	-	-	-	24.43	.814
December, .	-	-	-	-	-	-	-	-	-	-	25.77	.831
Total, .	224	45	7.82	55,930	7,910	-	-	-	-	-	313.23	-
Average, .	-	-	-	-	-	14.1	136.82	289.74	33,750,000	35,320,000	-	.858

TABLE No. 24. — Statement of Operation of Engines Nos. 13 and 14 at Hyde Park Pumping Station for the Year 1917.

MONTH.	ENGINE No. 13.		ENGINE No. 14.		Total Quantity pumped, 2 (Million Gallons).	Total Coal consumed in pumping and banking in (Pounds).	Total Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 2 Per Cent. allowed for Slip; No Deduction for Heating or Lighting.	AVERAGE LIFT (Feet).		Duty in Root-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement; No Deduction for Heating or Lighting.	Duty in Root-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Slip; No De- duction for Heating or Lighting.
	Hrs. Min.	Quantity pumped, 2 (Million Gal- lons).	Total Pumping Time.	Hrs. Min.	Quantity pumped, 2 (Million Gal- lons).					Engine No. 13.	Engine No. 14.		
January,	60 00	4.60	181 55	15 31	19 91	51,247	8,491	16.6	388.51	136.29	137.27	44,350,000	45,300,000
February,	228 20	17.13	34 40	2.11	19 24	51,535	9,050	17.5	371.18	136.74	135.20	42,240,000	43,150,000
March,	-	-	324 20	20.62	20 62	56,488	10,680	18.9	365.03	-	134.87	41,010,000	41,890,000
April,	74 25	5.22	212 40	14.52	19 74	52,093	9,372	18.0	378.94	134.84	134.83	42,490,000	43,400,000
May,	-	-	336 30	21.32	21 32	52,609	10,160	19.3	405.25	-	133.64	45,110,000	46,080,000
June,	8 40	.66	314 20	21.23	21 89	54,992	12,470	22.7	398.06	135.70	133.75	44,370,000	45,320,000
July,	-	-	336 00	25.21	25 21	61,621	12,844	20.8	409.11	-	132.43	45,130,000	46,100,000
August,	-	-	434 55	23.60	23 60	61,562	12,140	19.7	383.35	-	130.40	41,640,000	42,540,000
September,	7 30	.49	373 25	20.65	21 14	55,442	11,859	21.4	381.30	134.70	130.91	41,600,000	42,490,000
October,	-	-	413 35	22.77	22 77	56,217	11,285	15.1	405.04	-	132.03	44,550,000	45,510,000
November,	178 00	9.89	216 10	11.20	21 09	55,751	11,985	21.5	378.29	130.03	129.37	40,860,000	41,740,000
December,	439 05	22.86	-	-	22 86	61,138	12,093	19.8	373.91	133.18	-	41,480,000	42,370,000
Total,	996 00	60.85	3,228 30	198.54	259 39	670,995	132,409	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	19.7	386.88	134.09	132.89	42,880,000	43,800,000

TABLE No. 25. — (Meter Basis.) Average Daily Consumption of Water by Districts in the Cities and Towns supplied by the Metropolitan Water Works in 1917. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 27.)

MONTH.	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	SOUTHERN HIGH SERVICE.	NORTHERN HIGH SERVICE.	SOUTHERN EXTRA HIGH SERVICE.	NORTHERN EXTRA HIGH SERVICE.	Total District supplied (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
	Boston, excluding East Boston and Charlestown (Gallons).	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington (Gallons).	Quincy, Watertown, and Portions of Boston, Belmont and Milton (Gallons).	Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville (Gallons).	Portions of Boston and Milton (Gallons).	Lexington and Portions of Arlington and Belmont (Gallons).			
January, . . .	47,168,200	23,802,800	35,552,200	7,411,700	608,700	799,100	115,342,700	1,203,030	96
February, . . .	49,260,300	25,146,900	33,263,300	8,000,700	655,200	858,100	120,184,500	1,205,170	100
March, . . .	44,330,000	22,018,500	33,683,500	7,789,800	655,900	774,500	109,302,200	1,207,300	91
April, . . .	41,466,400	20,816,700	32,428,900	7,624,500	636,400	732,700	103,705,600	1,209,440	86
May, . . .	41,840,700	21,064,100	32,972,900	7,516,300	662,500	758,700	104,815,200	1,211,570	87
June, . . .	40,585,400	21,456,300	34,632,700	8,013,100	706,200	842,900	106,236,600	1,213,710	88
July, . . .	41,485,600	23,237,200	36,742,000	9,508,300	799,600	1,155,000	112,927,700	1,215,840	93
August, . . .	42,314,900	22,956,200	36,944,000	9,587,500	738,400	1,106,200	113,647,200	1,217,980	93
September, . . .	40,768,200	21,778,100	36,007,900	8,701,500	690,700	929,100	108,875,500	1,220,110	89
October, . . .	33,961,800	21,244,500	34,925,100	7,817,500	708,800	879,800	105,537,500	1,222,250	86
November, . . .	33,655,800	20,800,900	33,482,500	7,411,500	680,800	815,300	101,846,800	1,224,380	83
December, . . .	45,425,100	24,804,700	38,428,300	8,076,800	712,600	872,900	118,320,400	1,226,620	96
For the year, . . .	42,749,100	22,418,300	35,174,400	8,124,400	688,400	877,700	110,032,300	1,215,840	90

In addition to the above quantities the United States Government Reservation on Peddock's Island was supplied with 31,859,000 gallons, equivalent to a daily average rate of 87,300 gallons, and a part of Saugus with 4,706,000 gallons, equivalent to a daily average rate of 12,900 gallons.

TABLE No. 26. — (Meter Basis.) *Average Daily Consumption of Water in Cities and Towns supplied by the Metropolitan Water Works in 1917.*

City or town . . .	BOSTON.			SOMERVILLE.			MALDEN.			CHELSEA.			EVERETT.			QUINCY.			MEDFORD.		
	Population, . . .			91,060.			51,160.			46,300.			39,798.			43,119.			33,340.		
	GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
MONTH.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.
	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.
January, . . .	88,237,600	115	78	6,998,300	78	49	2,431,700	49	73	3,317,400	73	81	3,174,400	81	56	2,390,900	56	50	1,632,900	50	50
February, . . .	91,324,100	118	83	7,438,400	83	50	2,559,200	50	78	3,553,200	78	88	3,458,900	88	60	2,547,700	60	50	1,647,200	50	50
March, . . .	82,264,300	107	74	6,667,800	74	49	2,497,300	49	69	3,169,100	69	77	3,050,000	77	58	2,496,200	58	49	1,626,600	49	49
April, . . .	77,961,100	101	69	6,250,600	69	43	2,466,100	43	65	3,000,100	65	72	2,829,300	72	53	2,277,800	53	46	1,524,600	46	46
May, . . .	78,747,000	102	68	6,216,000	68	43	2,456,900	43	66	3,043,700	66	70	2,786,500	70	56	2,418,800	56	45	1,496,000	45	45
June, . . .	78,827,100	102	71	6,458,900	71	46	2,344,600	46	63	2,903,900	63	74	2,832,200	74	59	2,554,100	59	50	1,668,500	50	50
July, . . .	81,686,000	105	76	6,944,700	76	49	2,516,600	49	72	3,332,300	72	77	3,081,000	77	75	3,244,200	75	53	1,778,700	53	53
August, . . .	83,177,500	107	74	6,770,500	74	48	2,463,000	48	71	3,293,900	71	79	3,144,200	79	67	2,890,100	67	51	1,690,200	51	51
September, . . .	80,720,500	104	70	6,379,900	70	45	2,329,700	45	68	3,161,100	68	71	2,815,900	71	61	2,620,000	61	53	1,790,400	53	53
October, . . .	78,485,000	101	70	6,431,600	70	43	2,225,400	43	67	3,103,300	67	70	2,806,000	70	65	2,819,400	65	47	1,565,300	47	47
November, . . .	75,668,300	97	70	6,373,400	70	42	2,188,100	42	63	2,956,600	63	71	2,849,100	71	58	2,540,600	58	46	1,546,600	46	46
December, . . .	88,187,000	113	79	7,217,100	79	49	2,505,100	49	73	3,428,900	73	87	3,487,300	87	84	3,648,900	84	51	1,727,900	51	51
For the year, . . .	82,073,200	106	73	6,676,100	73	47	2,419,300	47	69	3,188,500	69	76	3,033,000	76	63	2,706,800	63	49	1,641,300	49	49

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town.	MONTH.	MELROSE.		REVERE.		WATERTOWN.		ARLINGTON.		MILTON.		WINTHROP.	
		17,560.		22,970.		17,900.		15,290.		9,050.		14,040.	
		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
		Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,		776,600	45	1,505,800	55	1,305,800	74	924,600	58	337,800	38	619,100	45
February,		837,500	48	1,641,600	60	1,303,400	74	987,500	62	346,600	39	653,000	47
March,		861,200	49	1,519,000	55	1,373,600	78	883,000	55	338,000	38	629,700	45
April,		838,500	48	1,473,700	53	1,364,500	77	831,500	52	339,000	38	652,100	47
May,		859,700	49	1,480,500	53	1,494,300	83	894,600	55	362,400	40	666,400	48
June,		927,600	53	1,566,900	56	1,783,500	100	962,100	59	400,100	44	732,600	52
July,		1,001,300	57	1,983,300	71	1,782,500	100	1,396,200	86	422,200	47	967,500	69
August,		1,021,300	58	1,984,800	70	1,833,700	102	1,235,300	76	399,200	44	994,400	71
September,		1,041,400	59	1,713,500	61	1,708,900	95	1,054,400	64	381,200	42	792,100	56
October,		950,700	54	1,477,200	52	1,663,200	92	933,200	57	405,300	45	699,200	49
November,		837,800	47	1,405,400	49	1,689,100	93	893,800	54	390,600	43	636,100	45
December,		875,800	50	1,623,400	57	1,702,100	94	959,900	58	375,000	41	674,000	47
For the year,		902,900	51	1,615,400	58	1,584,600	89	997,100	61	375,000	41	727,200	52

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	STONEHAM.			BELMONT.			LEXINGTON.			NAHANT.			SWAMPSCOTT.			METROPOLITAN DISTRICT.		
	7,690.			2,940.			5,790.			1,490.			7,770.			1,215,840.		
	GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
MONTH.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.	Per Day.		Per Capita.
	Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.	
January,	457,400	60		403,100	46		361,900	63		70,000	48		347,400	45		115,342,700	96	
February,	503,300	66		423,500	48		374,100	65		75,100	52		505,200	66		120,184,500	100	
March,	450,900	59		424,000	48		368,600	69		83,900	57		572,100	74		109,302,200	91	
April,	457,200	60		425,400	48		369,000	67		89,700	61		535,400	69		103,706,600	86	
May,	502,400	66		450,900	51		416,700	73		123,000	84		409,400	53		104,815,200	87	
June,	531,100	69		500,700	56		443,500	77		192,000	130		499,200	64		106,236,600	88	
July,	548,000	71		648,300	73		537,300	93		339,700	230		717,400	92		112,927,700	93	
August,	564,500	73		590,800	66		524,000	90		370,900	250		709,000	91		113,647,200	93	
September,	630,700	82		520,000	58		428,700	74		229,900	154		557,200	71		106,875,500	89	
October,	569,200	74		440,500	49		423,500	73		121,700	82		417,300	53		105,537,500	86	
November,	573,500	74		422,700	47		412,000	71		81,600	54		381,500	49		101,846,800	83	
December,	537,000	76		441,700	48		408,000	70		77,400	52		383,900	50		118,320,400	96	
For the year,	531,300	69		474,800	53		426,700	74		155,300	105		503,800	65		110,032,300	90	

TABLE No. 27. — (Pump Basis.) *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1917, and a Small Section of the Town of Saugus, from 1893 to 1917.*
[Gallons per Day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
January, .	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,890,000	90,442,000	100,055,000	111,275,000	118,435,000	125,176,000	137,771,000	130,878,000
February, .	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,476,000	103,454,000	98,945,000	117,497,000	117,268,000	122,728,000	143,222,000	140,595,000
March, .	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000	90,200,000	97,753,000	105,509,000	108,461,000	111,877,000	123,334,000	120,879,000
April, .	62,309,000	57,715,000	62,908,000	77,529,000	79,914,000	76,574,000	86,491,000	89,497,000	93,317,000	103,153,000	107,179,000	108,688,000	111,898,000
May, .	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000	76,677,000	89,446,000	87,780,000	95,567,000	106,692,000	111,589,000	111,715,000	115,804,000
June, .	63,374,000	68,329,000	69,905,000	77,639,000	77,962,000	83,468,000	97,691,000	98,581,000	103,420,000	110,002,000	105,590,000	111,209,000	117,441,000
July, .	69,343,000	73,642,000	69,667,000	80,000,000	85,535,000	88,228,000	90,821,000	107,798,000	106,905,000	108,340,000	107,562,000	113,584,000	124,769,000
August, .	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000	87,558,000	92,072,000	102,717,000	102,815,000	107,045,000	108,570,000	112,836,000	121,158,000
September, .	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000	91,478,000	108,612,000	102,103,000	107,752,000	106,772,000	114,188,000	120,103,000
October, .	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000	89,580,000	98,358,000	103,399,000	106,560,000	103,602,000	108,290,000	118,301,000
November, .	61,204,000	62,231,000	64,581,000	71,633,000	72,762,000	78,177,000	86,719,000	98,648,000	101,324,000	105,176,000	103,477,000	108,054,000	116,693,000
December, .	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000	85,340,000	97,844,000	113,298,000	125,494,000	114,721,000	125,119,000	122,696,000
Average, .	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000	92,111,000	98,089,000	104,645,000	110,345,000	110,277,000	118,114,000	121,671,000
Population, .	724,180	744,720	765,430	787,880	810,340	832,790	855,250	877,700	892,740	907,780	922,820	937,860	955,920
Per capita, .	91.4	87.8	90.8	99.5	99.7	100.4	107.7	111.7	117.2	121.6	119.5	125.9	127.3

See note at end of this table.

TABLE No. 27. — (Pump Basis.) *Consumption of Water, etc.* — Concluded.
[Gallons per Day.]

MONTH.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.
January, . . .	126,093,000	137,730,000	132,376,000	133,275,000	127,568,000	123,261,000	137,277,000	113,489,000	117,387,000	109,689,000	110,202,000	115,416,000
February, . . .	130,766,000	150,822,000	146,198,000	130,763,000	131,093,000	124,359,000	141,440,000	126,713,000	127,083,000	108,361,000	112,338,000	120,840,000
March, . . .	123,570,000	134,202,000	128,884,000	126,842,000	117,078,000	116,669,000	122,804,000	107,871,000	110,106,000	102,241,000	109,944,000	109,068,000
April, . . .	118,428,000	121,556,000	128,926,000	125,335,000	112,775,000	111,656,000	113,308,000	104,086,000	103,609,000	98,085,000	100,326,000	102,817,000
May, . . .	122,404,000	123,502,000	131,040,000	123,305,000	112,073,000	118,095,000	114,548,000	104,311,000	105,821,000	98,940,000	103,940,000	102,883,000
June, . . .	121,882,000	125,623,000	139,843,000	125,179,000	114,082,000	114,145,000	118,783,000	106,193,000	114,165,000	104,252,000	103,349,000	106,043,000
July, . . .	118,726,000	128,779,000	138,232,000	126,765,000	122,743,000	123,052,000	120,261,000	112,064,000	106,233,000	101,074,000	106,392,000	113,344,000
August, . . .	120,501,000	131,068,000	128,073,000	121,781,000	118,373,000	111,091,000	112,968,000	106,660,000	105,786,000	101,331,000	110,090,000	114,870,000
September, . . .	121,685,000	124,751,000	129,972,000	118,043,000	112,434,000	108,726,000	112,352,000	105,449,000	109,873,000	108,043,000	108,691,000	109,467,000
October, . . .	116,561,000	124,051,000	124,189,000	115,939,000	112,332,000	108,873,000	110,220,000	103,756,000	105,241,000	103,622,000	108,008,000	107,104,000
November, . . .	113,746,000	119,627,000	117,119,000	111,664,000	107,538,000	105,373,000	106,289,000	101,441,000	101,228,000	101,474,000	103,835,000	103,892,000
December, . . .	130,995,000	122,407,000	124,468,000	115,753,000	121,994,000	104,592,000	110,114,000	102,480,000	108,741,000	102,074,000	106,777,000	120,326,000
Average, . . .	122,085,000	128,561,000	130,712,000	122,851,000	117,458,000	113,951,000	118,546,000	107,466,000	109,489,000	103,227,000	106,994,000	110,475,000
Population, . . .	981,720	1,007,520	1,025,890	1,051,420	1,077,090	1,103,290	1,129,500	1,155,710	1,181,920	1,208,160	1,234,460	1,260,760
Per capita, . . .	124.4	127.6	127.4	116.8	109.1	103.3	105.0	93.0	92.6	85.4	86.7	87.6

This table includes the water consumed in the cities and towns enumerated in Table No. 26, together with the water consumed in Newton, which is included in the Metropolitan Water District but has not been supplied from the Metropolitan Works, and a small section of the town of Saugus.

TABLE No. 28. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.			AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	ALBUMINOID.				
											Dissolved.	Suspended.			
135174	Jan. 9	V. slight.	None.	.15	V. faintly vegetable.	Faintly vegetable.	2.85	1.00	.0022	.0108	.0096	.0012	.26	0.8	
135550	Feb. 6	None.	V. slight.	.12	V. faintly vegetable.	Faintly vegetable.	3.60	1.35	.0022	.0102	.0086	.0016	.28	1.0	
135901	Mar. 7	Slight.	Slight.	.15	None.	Faintly vegetable.	3.30	1.05	.0012	.0106	.0102	.0004	.27	0.8	
132262	Mar. 3	None.	Slight.	.15	Faintly vegetable.	Faintly vegetable.	3.40	1.00	.0012	.0134	.0106	.0028	.26	1.0	
136419	Apr. 24	Slight.	Slight.	.14	Faintly vegetable.	Faintly vegetable.	3.80	1.60	.0014	.0164	.0148	.0016	.26	1.0	
136480	May 1	None.	Slight.	.15	Faintly vegetable.	Faintly vegetable.	3.95	1.15	.0026	.0140	.0126	.0014	.26	1.0	
136730	May 15	Slight.	Slight.	.14	Faintly vegetable.	Faintly vegetable.	3.45	0.85	.0022	.0106	.0098	.0008	.26	1.0	
136913	June 5	Slight.	Slight.	.18	Faintly vegetable.	Faintly vegetable.	3.00	1.05	.0006	.0108	.0090	.0018	.26	1.0	
137234	July 2	None.	Slight.	.15	Faintly vegetable.	Faintly vegetable.	3.00	1.00	.0020	.0166	.0148	.0018	.26	1.0	
137617	July 17	Slight.	Slight.	.19	Faintly vegetable.	Faintly vegetable.	2.80	1.00	.0034	.0133	.0126	.0010	.29	1.0	
137959	Aug. 7	Slight.	Slight.	.15	Faintly vegetable.	Faintly vegetable.	4.35	1.85	.0020	.0142	.0128	.0014	.28	1.3	
138372	Sept. 11	V. slight.	V. slight.	.15	V. faintly vegetable.	V. faintly vegetable.	4.65	—	.0006	.0114	.0102	.0012	.25	1.0	
138575	Sept. 18	None.	V. slight.	.13	V. faintly vegetable.	V. faintly vegetable.	4.55	2.25	.0088	.0114	.0078	.0035	.26	1.3	
139074	Oct. 23	None.	V. slight.	.13	Faintly vegetable.	Distinctly vegetable.	2.75	—	.0018	.0148	.0086	.0062	.28	1.0	
139408	Nov. 13	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	—	—	.0022	.0106	.0100	.0006	.27	1.3	
139700	Nov. 27	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	3.05	—	.0031	.0146	.0130	.0016	.29	1.4	
139845	Dec. 11	None.	V. slight.	.12	V. faintly vegetable.	V. faintly vegetable.	3.50	—	.0018	.0108	.0100	.0008	.28	1.3	
Av.	.....	.....	.....	.14	.....	.....	3.50	1.31	.0023	.0126	.0109	.0017	.27	1.1

TABLE No. 29. — *Chemical Examinations of Water from the Sudbury Reservoir.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
135140	Jan. 5	V. slight.	V. slight.	.18	V. faintly vegetable.	Faintly vegetable.	3.65	1.05	.0022	.0128	.0094	.0034	.32	1.1
135583	Feb. 7	None.	V. slight.	.18	V. faintly fishy.	Faintly fishy.	4.25	1.50	.0020	.0136	.0108	.0028	.30	1.0
135943	Mar. 5	Slight.	Slight.	.15	Faintly vegetable.	Faintly vegetable.	3.70	1.60	.0020	.0110	—	—	.28	1.1
136251	Apr. 3	None.	Slight.	.15	Faintly vegetable.	Faintly vegetable.	4.20	1.50	.0068	.0146	.0132	.0014	.32	1.3
136485	May 1	Slight.	Slight.	.27	Faintly vegetable.	Faintly vegetable and unpleasant.	4.75	1.70	.0052	.0184	.0152	.0032	.28	1.1
136931	June 5	Slight.	Slight.	.19	Faintly vegetable.	Faintly vegetable.	5.10	2.60	.0058	.0134	.0118	.0016	.30	1.1
137373	July 5	Slight.	Slight.	.21	Faintly vegetable.	Faintly vegetable.	4.25	1.80	.0016	.0184	.0162	.0022	.30	0.6
137903	Aug. 6	Slight.	Slight.	.17	Faintly vegetable.	Distinctly vegetable.	4.25	1.50	.0010	.0192	—	—	.32	1.2
138300	Sept. 6	V. slight.	Slight.	.15	V. faintly vegetable.	Faintly vegetable.	3.90	—	.0022	.0138	.0114	.0024	.30	1.1
138310	Nov. 9	V. slight.	V. slight.	.13	V. faintly vegetable.	Faintly vegetable.	—	—	.0048	.0190	.0116	.0044	.29	1.4
138609	Dec. 6	None.	V. slight.	.19	V. faintly vegetable.	V. faintly vegetable.	3.80	1.65	.0020	.0170	.0144	.0026	.33	1.6
Av.	.....	.....	.....	.18	.....	.....	4.19	1.66	.0032	.0153	.0127	.0026	.30	1.1

TABLE No. 30. — *Chemical Examinations of Water from Spot Pond, Stoneham.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ONOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
135155	Jan. 8	V. slight.	V. slight.	.10	V. faintly unpleasant, fishy.	Faintly unpleasant, fishy.	4.20	1.45	.0028	.0120	.0094	.0026	.38	1.3
135534	Feb. 5	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	3.60	0.95	.0024	.0154	.0136	.0018	.36	1.3
135851	Mar. 5	Slight.	Slight.	.10	Faintly unpleasant, cucumber.	Faintly unpleasant, cucumber.	4.20	1.85	.0022	.0162	.0130	.0032	.36	1.3
136273	Apr. 4	Slight.	None.	.10	Faintly cucumber.	Faintly cucumber.	3.65	1.45	.0012	.0144	.0102	.0042	.32	1.1
136555	May 7	Slight.	Slight.	.10	Faintly cucumber.	Distinctly cucumber.	3.70	1.50	.0020	.0206	.0200	.0006	.30	1.3
136986	June 11	Slight.	Slight.	.06	Faintly vegetable.	Faintly vegetable.	3.30	1.15	.0020	.0150	.0134	.0016	.30	1.1
137424	July 9	None.	Slight.	.09	Faintly vegetable.	Faintly vegetable.	4.00	1.70	.0008	.0184	.0156	.0028	.30	0.8
138012	Aug. 13	Slight.	Slight.	.10	Faintly vegetable.	Faintly vegetable.	3.25	1.05	.0012	.0174	.0144	.0030	.34	1.3
138324	Sept. 10	Slight iron.	Considerable iron.	.10	V. faintly vegetable.	V. faintly vegetable.	5.05	-	.0016	.0162	.0112	.0050	.30	1.4
138535	Nov. 19	None.	V. slight.	.10	V. faintly vegetable.	Faintly vegetable.	-	-	.0024	.0184	.0168	.0016	.30	1.4
139004	Dec. 10	None.	None.	.10	V. faintly unpleasant.	Faintly fishy.	-	-	.0012	.0145	.0108	.0038	.30	1.4
Av.	.....	.....	.....	.10	.....	.....	3.88	1.39	.0018	.0163	.0135	.0027	.32	1.2

TABLE No. 31. — *Chemical Examinations of Water from Lake Cochiuate.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
135162	Jan. 8	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	6.60	1.70	.0076	.0222	.0164	.0053	.74	2.3
135554	Feb. 5	V. slight.	V. slight.	.20	Faintly vegetable.	Distinctly vegetable.	7.00	2.10	.0060	.0240	.0186	.0054	.74	2.5
135372	Mar. 6	Slight.	Slight.	.25	Faintly vegetable.	Faintly vegetable.	6.65	2.45	.0054	.0226	.0200	.0026	.74	2.5
136239	Apr. 2	Slight.	Considerable.	.26	Faintly vegetable.	Faintly vegetable.	5.95	2.20	.0036	.0226	.0178	.0048	.68	2.3
136482	May 1	Slight.	Slight.	.22	Faintly vegetable.	Faintly vegetable.	6.65	1.65	.0008	.0274	.0204	.0070	.70	2.1
136993	June 4	None.	Slight.	.20	Faintly vegetable.	Faintly vegetable.	6.30	1.75	.0022	.0208	.0168	.0040	.70	2.1
137370	July 5	Slight.	Slight.	.21	Faintly unpleasent.	Faintly unpleasent.	6.10	1.00	.0022	.0188	.0182	.0006	.68	2.1
137897	Aug. 6	Slight.	Slight.	.15	Faintly vegetable and marshy.	Faintly vegetable and marshy.	7.20	2.55	.0022	.0306	.0242	.0064	.70	2.3
138258	Sept. 4	V. slight.	V. slight.	.15	V. faintly vegetable.	V. faintly vegetable.	6.75	—	.0008	.0232	.0184	.0048	.70	2.6
139307	Nov. 9	V. slight.	V. slight.	.20	V. faintly vegetable and sweetish.	V. faintly vegetable and sweetish.	—	—	.0132	.0264	.0196	.0068	.70	3.0
139798	Dec. 7	V. slight.	V. slight.	.16	V. faintly vegetable and unpleasent.	V. faintly vegetable and unpleasent.	6.65	2.65	.0078	.0242	.0204	.0038	.73	3.1
Av.	.....	.....	.....	.20	.....	.....	6.59	2.01	.0047	.0239	.0192	.0047	.71	2.4

TABLE No. 32. — *Chemical Examinations of Water from a Tap at the State House, Boston.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
135087	Jan. 2	V. slight.	None.	.15	None.	V. faintly vegetable.	4.00	1.90	.0018	.0138	.0116	.0022	.35	1.3
135535	Feb. 6	None.	V. slight.	.14	V. faintly vegetable.	Faintly fishy.	4.45	1.50	.0018	.0116	.0112	.0004	.34	1.1
135879	Mar. 7	Slight.	Slight.	.20	None.	Faintly vegetable.	4.25	1.50	.0024	.0136	.0116	.0020	.33	1.3
136459	Apr. 30	Slight.	Slight.	.18	Faintly vegetable and fishy.	Faintly unpleasant and fishy.	4.40	1.85	.0016	.0170	.0148	.0022	.32	1.3
136887	June 4	Slight.	Slight.	.18	Faintly vegetable.	Distinctly vegetable.	4.25	1.35	.0006	.0160	.0133	.0022	.32	1.3
138243	Sept. 4	V. slight.	V. slight.	.15	V. faintly vegetable.	Faintly vegetable.	5.75	2.00	.0008	.0158	.0140	.0018	.30	2.1
139233	Nov. 6	V. slight.	None.	.11	V. faintly vegetable.	Faintly vegetable.	-	-	.0014	.0116	.0106	.0010	.32	1.4
139764	Dec. 3	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	4.05	-	.0018	.0144	.0116	.0028	.33	1.6
Av.	.....	.....	.....	.15	.....	.....	4.45	1.68	.0015	.0142	.0124	.0018	.33	1.4

TABLE No. 33. — *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1917.*
[Parts per 100,000.]

LOCALITY.	Samples collected.	COLOR. Platinum Standard.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
			Total.	Loss on Ignition.	Free.	ALBUMINOID.				
						Total.	Dissolved.	Suspended.		
Quinepoxet River, Holden, ¹	Semi-monthly.	.43	4.41	1.53	.0023	.0177	.0156	.0021	.38	0.9
Stillwater River, Sterling, ²	Semi-monthly.	.30	3.78	1.48	.0018	.0135	.0124	.0011	.23	1.0
Wachusett Reservoir, West Boylston, ²	Semi-monthly.	.26	3.51	1.44	.0024	.0152	.0133	.0019	.27	1.0
Wachusett Reservoir, Clinton, surface, ³	Semi-monthly.	.14	3.50	1.34	.0023	.0126	.0109	.0017	.27	1.1
Wachusett Reservoir, Clinton, bottom, ³	Semi-monthly.	.17	3.62	1.30	.0017	.0106	.0100	.0008	.27	1.0
Marlborough (Walker's Brook), ⁴	Monthly.	.49	17.93	4.97	.1219	.0305	.0249	.0056	2.71	6.4
Marlborough Brook filter beds, effluent, ⁵	Monthly.	.12	16.06	—	.0024	.0121	—	—	2.34	5.9
Wachusett Aqueduct, Southborough, ⁴	Monthly.	.20	4.22	1.71	.0022	.0131	.0121	.0010	.30	1.1
Sudbury Reservoir, surface, ⁴	Monthly.	.18	4.19	1.66	.0032	.0153	.0127	.0026	.37	1.1
Sudbury Reservoir, bottom, ⁴	Monthly.	.17	3.97	1.38	.0047	.0155	.0132	.0023	.31	1.2
Framingham Reservoir No. 3, inlet, ⁴	Monthly.	.15	4.04	1.43	.0032	.0145	.0124	.0021	.31	1.2
Framingham Reservoir No. 3, near dam, ⁴	Monthly.	.17	4.00	1.42	.0027	.0168	.0135	.0033	.32	1.2
Hopkinton Reservoir, inlet, ⁴	Monthly.	1.31	6.20	3.04	.0041	.0354	.0311	.0043	.48	1.4
Hopkinton Reservoir, surface, ⁴	Monthly.	.66	4.71	1.94	.0025	.0220	.0201	.0019	.40	1.2
Hopkinton Reservoir, bottom, ⁴	Monthly.	.62	4.94	2.13	.0033	.0215	.0183	.0032	.40	1.1
Ashland Reservoir, inlet, ⁴	Monthly.	1.35	6.95	3.30	.0035	.0382	.0331	.0051	.46	1.6
Ashland Reservoir, surface, ⁴	Monthly.	.65	4.85	2.22	.0025	.0254	.0220	.0034	.35	1.3
Ashland Reservoir, bottom, ⁴	Monthly.	.62	4.96	2.23	.0033	.0235	.0193	.0042	.35	1.3
Framingham Reservoir No. 2, inlet, ⁴	Monthly.	.78	5.33	2.70	.0049	.0277	.0233	.0044	.45	1.4
Framingham Reservoir No. 2, near dam, ⁴	Monthly.	.72	5.32	2.04	.0046	.0256	.0222	.0034	.43	1.3
Lake Cochituate, surface, ⁴	Monthly.	.26	6.59	2.01	.0047	.0239	.0192	.0047	.71	2.4
Lake Cochituate, bottom, ⁴	Monthly.	.31	7.52	2.60	.0076	.0279	.0200	.0079	.72	2.7
Weston Reservoir, ⁴	Monthly.	.17	3.95	1.37	.0029	.0161	.0134	.0027	.32	1.3
Terminal chamber, Sudbury Aqueduct, ⁴	Monthly.	.17	3.84	1.44	.0023	.0153	.0127	.0026	.32	1.3
Spot Pond, ⁴	Monthly.	.10	3.88	1.39	.0018	.0162	.0135	.0027	.32	1.2
Tap in Revere, ⁴	Monthly.	.10	4.20	1.53	.0017	.0148	.0127	.0021	.32	1.3
Tap at State House, ⁵	Monthly.	.15	4.45	1.68	.0015	.0142	.0124	.0018	.33	1.3
Tap in Quincy, ⁴	Monthly.	.15	4.10	1.51	.0008	.0126	.0107	.0019	.32	1.3

¹ Averages of 15 samples.² Averages of 17 samples.³ Averages of 16 samples.⁴ Averages of 11 samples.⁵ Averages of 8 samples.

TABLE No. 34. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1917.*

[Parts per 100,000.]

YEAR.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Oxygen consumed.	Hardness.
	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.					
					Total.	Dissolved.	Suspended.			
1892, . . . . .	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	-	1.9
1893, . . . . .	.53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.60	1.8
1894, . . . . .	.58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.63	1.7
1895, . . . . .	.59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.69	0.7
1896, . . . . .	.45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.56	1.4
1897, . . . . .	.55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.64	1.6
1898, . . . . .	.40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.44	1.4
1899, . . . . .	.28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.35	1.1
1900, . . . . .	.29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.38	1.3
1901, . . . . .	.29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.42	1.7
1902, . . . . .	.30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.40	1.3
1903, . . . . .	.29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.39	1.5
1904, . . . . .	.23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.37	1.5
1905, . . . . .	.24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.35	1.4
1906, . . . . .	.24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.36	1.3
1907, . . . . .	.22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.32	1.3
1908, . . . . .	.19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.26	1.2
1909, . . . . .	.18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.25	1.3
1910, . . . . .	.14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.22	1.1
1911, . . . . .	.25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.33	1.4
1912, . . . . .	.17	3.86	1.23	.0018	.0154	.0119	.0034	.36	.29	1.7
1913, . . . . .	.13	3.96	1.15	.0014	.0150	.0120	.0026	.35	.26	1.5
1914, . . . . .	.14	4.12	1.19	.0014	.0138	.0116	.0022	.39	.25	1.4
1915, . . . . .	.16	3.73	1.04	.0015	.0157	.0134	.0023	.38	.25	1.4
1916, . . . . .	.18	4.53	1.85	.0013	.0133	.0107	.0026	.36	-	1.4
1917, . . . . .	.15	4.45	1.68	.0015	.0142	.0124	.0018	.33	-	1.3

TABLE No. 35. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1917 inclusive.*
 [Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WACHUSETT RESERVOIR.		SUDBURY RESERVOIR.		LAKE COCHITUATE.		FRAMINGHAM RESERVOIR.		FRAMINGHAM RESERVOIR.		ASHLAND RESERVOIR.		HOPKINTON RESERVOIR.		WHITEHALL RESERVOIR.	
	Surface.	Bottom.	Surface.	Bottom.	Surface.		Surface.	Bottom.	No. 3.	Mid-depth.	Surface.	Surface.	Surface.	Surface.	Surface.	Surface.
					Surface.	Bottom.										
1898.	-	-	354	149	830	696	390	245	263	944	690					
1899.	-	-	470	252	905	644	440	218	357	715	383					
1900.	-	-	498	361	1,758	1,071	645	365	390	980	437					
1901.	-	-	337	225	992	702	336	149	244	450	705					
1902.	-	-	590	402	1,071	730	627	204	550	588	198					
1903.	-	-	649	388	931	795	459	169	323	231	327					
1904.	-	-	517	376	663	542	475	174	153	106	375					
1905.	-	-	644	502	1,255	503	535	158	289	240	147					
1906.	-	-	772	953	1,407	1,143	692	226	431	475	1,279					
1907.	-	-	212	513	1,123	1,200	413	205	378	336	961					
1908.	-	-	466	885	1,559	1,241	932	725	699	516	708					
1909.	-	-	1,937	2,474	2,513	1,142	2,372	610	603	294	445					
1910.	-	-	480	328	464	556	455	436	426	387	154					
1911.	-	-	649	368	990	988	1,942	378	592	457	397					
1912.	-	-	585	368	939	882	4,082	241	665	516	390					
1913.	-	-	449	270	553	541	4,964	253	414	298	494					
1914.	-	-	753	309	735	692	2,036	-	327	325	89					
1915.	-	-	519	356	1,005	828	1,900	-	450	284	625					
1916.	-	-	922	550	930	992	2,708	-	425	347	148					
1917.	-	-	296	240	1,670	2,216	663	-	-	-	-					

See note at end of this table.

TABLE No. 35. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.		SPOT POND.		CHESTNUT HILL RESERVOIR.				TAPS.			
	SURFACE.		SURFACE.		SUDBURY AQUEDUCT.		COCHITUATE AQUEDUCT.		EFFLUENT GATE-HOUSE.		SOUTHERN LOW SERVICE.	SOUTHERN HIGH SERVICE.
					Inlet.		Inlet.		No. 2.			
1898,	-		435		804		544		304		230	-
1899,	-		1,129		359		992		329		192	-
1900,	-		573		568		1,139		897		468	-
1901,	-		628		344		687		413		243	-
1902,	-		581		563		937		525		367	-
1903,	-		650		450		860		435		286	-
1904,	-		465		405		838		472		303	-
1905,	-		609		551		904		554		470	-
1906,	783		671		631		1,042		721		671	274
1907,	443		590		349		909		419		583	363
1908,	979		741		783		1,073		689		312	326
1909,	2,399		1,079		1,999		632		1,899		666	205
1910,	625		622		457		-		465		1,913	443
1911,	934		748		700		1,382		954		447	677
1912,	1,117		716		855		3,887		919		221	374
1913,	565		607		535		2,622		850		735	461
1914,	757		648		492		-		531		967	413
1915,	725		656		643		-		601		410	463
1916,	857		811		842		-		601		603	287
1917,	570		446		598		638		717		597	356
									1,041		872	412
									717		409	419
											534	520
											352	294

NOTE. — A large growth of *Asterionella* originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 36. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1917 inclusive.*

[Averages of weekly determinations.]

YEAR.	CHESTNUT HILL RESERVOIR.			SOUTHERN SERVICE TAPS.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 150 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	—
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	—	180	178	213
1911,	205	204	151	175	197
1912,	429	450	227	249	259
1913,	123	243	157	119	140
1914,	288	—	252	174	220
1915,	163	—	128	117	134
1916,	128	—	85	102	105
1917,	178	112	119	119	141
Averages,	224	196	180	153	208

TABLE No. 37. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1917 (Averages of Weekly Determinations.)*
[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.				SUDBURY RESERVOIR.				FRAMINGHAM RESERVOIR, No. 3.	LAKE COCHITWATE.				CHESTNUT HILL RESERVOIR.			SPOT POND.	FELS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.			
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Quinepoxtet River.	Stillwater River.	Surface.	Mid-depth.		Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Influent Streams. ¹	Inlet (Sudbury Aqueduct).			Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Mid-depth.	Effluent Gate-house.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).
January,	11	11	11	27	40	27	11	11	11	11	11	11	14	17	27	11	11	11	5	5	10	11	11	11
February,	7	9	9	26	28	21	11	11	11	10	11	15	15	18	27	12	12	10	9	9	10	11	11	10
March,	9	9	10	26	28	23	11	11	12	30	12	19	19	18	36	15	15	11	4	4	10	11	11	11
April,	9	9	9	19	32	27	11	12	14	21	15	17	17	17	30	15	12	12	4	4	12	12	12	12
May,	9	9	9	25	35	27	11	14	14	14	14	14	14	14	31	14	12	12	4	4	12	12	12	13
June,	10	10	9	33	43	40	11	15	14	14	14	13	13	13	13	13	11	11	4	4	12	12	12	12
July,	9	9	9	26	36	27	11	12	12	10	12	13	13	13	13	12	12	11	5	4	11	11	11	11
August,	11	12	12	18	34	21	11	13	12	13	13	13	13	13	13	12	12	11	6	6	11	11	11	12
September,	11	12	12	16	35	16	11	12	12	14	13	13	13	13	13	11	11	10	6	6	11	11	11	12
October,	11	11	10	19	43	19	11	11	16	11	11	13	13	13	13	11	11	10	6	6	11	11	11	10
November,	10	10	10	18	35	19	11	12	12	16	12	13	13	13	13	12	12	10	6	6	11	11	11	11
December,	9	10	10	11	32	17	11	13	13	12	12	12	15	16	30	12	11	11	5	5	11	11	11	11
Averages,	10	10	10	22	36	24	12	12	12	15	12	15	15	16	21	27	12	11	5	5	11	11	11	11

¹ The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given in combining the results to the sizes of the streams.

TABLE No. 38. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1917. (Averages of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high-water mark.]

[Degree Fahrenheit.]

MONTH.	WACHSSETT ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 107 FEET).			SUDBURY ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).			WACHSSETT AQUEDUCT.			FRAMINGHAM ¹ RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE ¹ (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).			CHEST-NUT HILL RESERVOIR.			SPOT POND ¹ (DEPTH AT PLACE OF OBSERVATION 23.0 FEET).			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.			Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 180 Boylston Street, Boston (Low Service).	Tap at Ashburton Place, Boston (High Service).
January, .	33.9	34.2	34.6	34.7	36.2	36.3	34.2	33.5	34.5	35.9	36.7	36.2	34.4	35.0	35.1	36.7	37.1	37.0	35.4	36.2	37.5	30.0	38.0	38.0	39.9
February, .	34.4	34.5	34.6	34.5	35.5	36.3	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
March, .	34.9	35.2	35.5	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
April, .	35.6	35.7	35.7	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
May, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
June, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
July, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
August, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
September, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
October, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
November, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
December, .	35.8	35.8	35.8	34.5	36.0	36.8	34.5	33.5	34.5	36.4	36.7	36.2	34.7	35.4	35.2	37.1	37.0	36.2	36.2	37.4	37.5	36.8	38.0	38.3	39.3
Averages, .	49.5	46.2	40.2	50.6	49.4	49.1	45.3	45.3	51.0	51.7	48.7	52.4	40.1	38.9	51.8	50.9	51.4	50.0	52.1	52.4	52.6	52.6	52.6	52.6	54.8

¹ Surface temperatures are averages of weekly determinations. Mid-depth and bottom temperatures are averages of biweekly determinations.

TABLE No. 39. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1917.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	54	1	29.0	53	0	27.0	51	—4	25.4
February,	53	—6	25.4	49	—6	24.7	50	—19	21.5
March,	60	9	36.2	57	7	35.2	57	3	33.6
April,	71	24	44.2	70	24	44.3	69	23	42.4
May,	82	33	50.9	80	34	50.9	77	33	48.8
June,	90	44	66.9	88	44	66.9	83	47	64.3
July,	98	53	73.4	98	53	74.1	94	54	71.6
August,	99	54	73.2	100	48	73.2	95	50	69.5
September,	82	33	61.9	81	33	58.8	77	30	56.1
October,	70	29	51.0	70	29	49.7	79	30	48.7
November,	63	11	38.0	63	11	37.0	62	10	36.4
December,	45	—14	24.2	42	—14	22.1	44	—16	22.9
Averages,	—	—	45.6	—	—	47.0	—	—	45.1

TABLE No. 40. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1917.*

	DIAMETER OF PIPES IN INCHES.															Total.
	60	48	42	40	36	30	24	20	16	14	12	10	8	6	4	
Total length owned and operated Dec. 31, 1916 (feet).	43,802	211,092	9,810	6,989	61,787	49,687	85,349	76,069	67,798	26	26,507	3,786	1,878	985	33	645,598
Gate valves in same,	5	54	1	2	55	42	59	55	81	1	106	18	18	23	1	521
Air valves in same,	51	125	5	3	44	21	42	45	34	-	10	1	-	-	-	381
Length laid or relaid during 1917 (feet),	-	113	-	-	-	141	184	170	67	-	41	43	-	9	-	768
Gate valves in same,	-	2	-	-	-	2	2	-	1	-	3	2	-	-	-	12
Air valves in same,	-	4	-	-	-	4	1	1	-	-	-	-	-	-	-	10
Length abandoned during 1917 (feet),	-	113	-	-	-	57	41	180	9	-	2	-	-	-	-	402
Gate valves in same,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Air valves in same,	-	4	-	-	-	4	-	1	-	-	-	-	-	-	9	9
Length owned and operated Dec. 31, 1917 (feet).	43,802 ¹	211,092	9,810	6,989	61,787	49,772 ²	85,492	76,059	67,856	26	26,546	3,829	1,878	994	33	645,994 ³
Gate valves in same,	5	56	1	2	55	44	61	55	82	1	109	20	18	23	1	533
Air valves in same,	51	125	5	3	44	21	43	45	34	-	10	1	-	-	-	382

¹ Includes 2,035 feet of 76-inch concrete-lined pressure tunnel; 363 feet of 76-inch mortar-lined and concrete-covered steel pipe; 21 feet of 76-inch cast-iron pipe and 85 feet of 60-inch concrete-covered steel pipe.

² Includes 15,512 feet of 30-inch mortar-lined and covered wrought-iron pipe.

³ 122.34 miles.

TABLE No. 41. — *Statement of Cast-iron Hydrant, Blow off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1917.*

	DIAMETER OF PIPES IN INCHES.								Total.
	24	20	16	12	10	8	6	4	
Total length in use Dec. 31, 1916 (feet),	352	292	3,121	6,697	176	501	3,509	1,472	16,120
Valves in same,	-	-	30	107	2	8	81	43	271
Length laid or relaid in 1917 (feet),	-	-	-	164	-	12	6	-	182
Valves in same,	-	-	-	1	-	1	1	-	3
Length abandoned in 1917 (feet),	-	-	-	-	-	-	-	-	-
Valves in same,	-	-	-	-	-	-	-	-	-
Total length in use Dec. 31, 1917 (feet),	352	292	3,121	6,861	176	513	3,515	1,472	16,302 ¹
Valves in same,	-	-	30	108	2	9	82	43	274

¹ 3.09 miles.

TABLE NO. 42. — Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1917.

BY WHOM OWNED.	INCHES.														TOTALS.					
	60	48	43	40	36	30	28	24	20	18	16	14	12	10	8	7	6	4	Feet.	Miles.
Metropolitan Water Works.	43,802	211,062	9,810	6,989	61,737	49,771	—	85,492	76,058	—	67,856	26	26,546	3,829	1,878	—	994	33	645,964	122.34
Boston.	—	10,637	15,476	16,105	37,147	93,071	244	79,082	87,058	—	256,804	5,021	1,434,402	373,701	810,714	—	1,255,249	106,067	4,581,378	867.68
Somerville.	—	—	—	—	—	—	—	—	4,210	387	4,021	7,950	91,989	57,049	108,010	—	214,315	21,960	509,771	96.55
Malden.	—	—	—	—	—	—	—	—	—	—	5,547	9,155	80,822	31,276	81,868	—	221,371	55,360	485,199	91.89
Chelsea.	—	—	—	—	—	—	—	—	—	—	5,176	—	12,479	39,898	30,268	—	143,240	6,656	237,645	45.01
Everett.	—	—	—	—	—	—	—	2,484	2,900	—	5,204	5,998	6,084	42,804	25,258	—	145,559	30,600	266,391	50.55
Quincy.	—	—	—	—	—	—	—	—	2,679	—	23,232	—	29,126	43,941	139,572	994	367,144	96,542	703,229	133.19
Medford.	—	—	—	—	—	—	—	—	673	—	6,775	9,598	32,296	39,302	95,869	—	163,842	26,558	375,213	71.06
Melrose.	—	—	—	—	—	—	—	—	—	—	5,223	3,024	23,197	19,846	25,720	—	151,405	56,851	283,266	54.03
Revere. ¹	—	—	—	—	—	—	—	—	—	—	23,813	6,970	24,077	28,037	34,690	—	103,118	71,806	292,513	55.40
Watertown.	—	—	—	—	—	—	—	—	—	—	400	11,877	5,969	15,724	27,379	—	142,558	11,816	215,713	40.85
Arlington.	—	—	—	—	—	—	—	—	—	—	—	—	24,136	28,503	40,209	—	143,927	15,611	252,386	47.80
Milton.	—	—	—	—	—	—	—	—	—	—	103	44	22,556	20,926	53,689	—	156,190	17,027	270,535	51.24
Winthrop.	—	—	—	—	—	—	—	—	—	—	—	—	4,049	24,073	33,987	—	54,039	57,041	173,189	32.80
Stoneham.	—	—	—	—	—	—	—	—	—	—	—	—	7,425	1,825	5,110	—	107,434	18,425	140,219	26.56
Belmont.	—	—	—	—	—	—	—	—	—	—	—	—	5,714	16,964	26,557	—	113,088	269	162,582	30.79
Lexington.	—	—	—	—	—	—	—	—	—	—	—	—	9,000	4,879	35,433	—	119,991	27,794	197,097	37.33
Nahant.	—	—	—	—	—	—	—	—	—	—	—	4,000	150	11,550	4,800	—	36,800	59,208	116,508	22.07
Swampscott.	—	—	—	—	—	—	—	—	—	—	—	3,045	6,714	18,306	6,593	—	83,817	9,025	127,500	24.15
Total feet.	43,802	221,726	25,286	23,094	98,024	142,842	244	167,058	173,579	367	404,154	66,708	1,346,720	822,351	1,587,604	994	3,723,881	689,451	10,038,768	—
Total miles.	8.30	41.99	4.79	4.37	13.74	27.05	0.05	31.64	32.88	0.07	76.55	12.63	349.75	155.75	300.68	0.19	705.28	130.58	—	1,901.29

¹ Includes small portion of Saugus.

TABLE No. 43. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1917, and the Number of Services and Meters installed during the Year 1917.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services installed.	Meters installed.
Boston,	105,352	63,071	9,616	1,140	2,172
Somerville,	13,509	10,028	1,235	154	317
Malden,	8,126	7,862	604	29	80
Chelsea,	5,178	5,167	400	58	59
Everett,	6,018	3,530	585	41	264
Quincy,	9,977	9,119	1,141	285	263
Medford,	6,600	6,600	708	196	369
Melrose,	4,167	4,354	376	72	72
Revere, ¹	4,707	3,603	303	135	254
Watertown,	3,132	3,139	411	168	172
Arlington,	3,108	3,108	500	170	170
Milton,	2,030	2,030	439	70	70
Winthrop,	3,016	2,945	300	66	46
Stoneham,	1,647	1,639	156	13	28
Belmont,	1,729	1,729	249	98	101
Lexington,	1,241	1,231	220	37	92
Nahant,	730	550	101	12	34
Swampscott,	1,925	1,925	199	59	59
Totals,	182,192	131,630	17,543	2,803	4,622

¹ Includes small portion of Saugus.

TABLE No. 44. — Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base for Each Month at Stations on Metropolitan Water Works during 1917.

1917. MONTH.	LOW SERVICE.										SOUTHERN HIGH SERVICE.							
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		SOMERVILLE PUBLIC LIBRARY, HIGHLAND AVENUE.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE.		BOSTON METRO- POLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.		BELMONT WATER WORKS SHOP, WAYER- LEY STREET.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	
January, .	163	145	175	170	166	163	169	163	166	163	165	154	248	224	263	246	261	247
February, .	160	140	175	171	167	163	169	164	165	162	162	152	248	233	262	247	260	246
March, .	163	139	175	169	167	163	168	165	165	162	164	154	248	234	261	243	262	245
April, .	165	146	174	167	166	163	169	164	165	163	164	156	249	234	262	242	261	242
May, .	164	146	174	170	167	163	167	162	165	162	164	155	248	234	260	240	260	239
June, .	162	142	173	167	166	162	167	162	165	161	164	154	248	233	258	233	257	230
July, .	163	146	178	171	168	161	171	163	166	161	165	154	248	232	258	226	259	222
August, .	164	147	176	169	167	161	171	164	165	162	164	154	248	231	257	230	256	226
September, .	161	149	175	170	166	161	167	163	165	162	164	154	248	231	257	235	255	222
October, .	158	149	174	170	166	161	168	163	165	163	164	155	248	230	260	237	259	239
November, .	156	147	175	170	166	161	167	162	167	163	166	158	249	233	259	236	268	240
December, .	151	142	176	170	165	161	167	162	165	162	164	156	247	231	259	237	267	238
Averages, .	161	145	175	170	166	162	168	163	165	162	164	155	248	233	260	238	259	237

TABLE No. 44. — Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base, etc. — Concluded.

1917. MONTH.	SOUTHERN HIGH SERVICE — Concluded.						NORTHERN HIGH SERVICE.						NORTHERN EXTRA HIGH SERVICE.					
	MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STA- TION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP TOWN HALL, MASSACHUSETTS AVENUE.		Minimum.	Maximum.
	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.		
January, .	248	238	244	234	244	230	271	252	269	264	267	257	264	254	196	187	430	422
February, .	248	237	244	234	244	228	269	251	269	265	266	255	263	248	196	188	429	418
March, .	249	239	244	233	244	229	270	251	270	265	266	255	262	250	198	189	430	418
April, .	250	240	244	235	244	231	270	251	270	265	266	257	263	250	202	191	430	421
May, .	249	238	244	233	244	230	268	250	271	265	267	256	264	251	191	177	430	420
June, .	248	237	243	231	243	228	268	248	270	264	265	253	259	243	190	174	426	417
July, .	247	234	243	227	242	220	266	243	269	262	261	242	245	216	190	165	421	408
August, .	246	235	243	230	243	223	266	243	269	263	260	242	244	220	190	170	421	408
September, .	246	237	244	232	243	227	267	246	269	264	260	249	-	-	192	174	427	416
October, .	247	235	243	231	243	223	269	246	270	265	261	253	-	-	191	180	427	416
November, .	248	238	244	233	244	229	271	248	270	265	266	254	262	252	192	181	429	419
December, .	246	234	240	227	239	220	269	247	270	265	263	254	260	250	193	180	429	419
Averages, .	248	237	243	232	243	227	269	248	270	264	264	252	259	243	193	180	427	417

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1917.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns:—

CITY OR TOWN.	Population, Census of 1915.	Estimated Population, July 1, 1917.
Boston,	745,439	776,520
Somerville,	86,854	91,060
Malden,	48,907	51,160
Chelsea,	43,426	46,300
Newton, ¹	43,113	44,640
Everett,	37,718	39,780
Quincy,	40,674	43,110
Medford,	30,509	33,340
Melrose,	16,880	17,560
Revere,	25,178	28,070
Watertown,	16,515	17,900
Arlington,	14,889	16,290
Milton,	8,600	9,050
Winthrop,	12,758	14,040
Stoneham,	7,489	7,680
Swampscott,	7,345	7,770
Lexington,	5,538	5,790
Belmont,	8,081	8,940
Nahant,	1,387	1,480
Total population of Metropolitan Water District,	1,201,300	1,260,480
Saugus, ²	280	280

¹ Not regularly supplied from the Metropolitan Water Works, but an emergency supply was furnished Jan. 22, 1918.

² Only a small portion of Saugus was supplied with water.

*Pumping.**Chestnut Hill Pumping Station No. 1:—*

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used:— Bituminous: 72.8 per cent. Ake Mine and Davenport. Anthracite: screenings 27.2 per cent. Price per gross ton in bins: bituminous \$4.51 to \$7.65, screenings \$4.21 to \$4.47. Average price per gross ton \$5.16. Per cent. ashes 13.2.

Chestnut Hill Pumping Station No. 2:—

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used:— Bituminous: 62.5 per cent. Ake Mine and Davenport. Anthracite: screenings 37.5 per cent. Price per gross ton in bins: bituminous \$4.36 to \$10.51, screenings \$3.25 to \$4.29. Average price per gross ton \$5.37. Per cent. ashes 17.5.

Spot Pond Station:—

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used:— Bituminous: 65.3 per cent. Davenport. Anthracite: screenings 34.7 per cent. Price per gross ton in bins: bituminous \$6.64 to \$9.49, screenings \$5.39. Average price per gross ton \$7.56. Per cent. ashes 16.1.

	CHESTNUT HILL PUMPING STATIONS.			
	No. 1.			No. 2.
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Engine No. 12.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000	40,000,000
Coal consumed for year (pounds),	2,073,543	20,014	1,992,650	6,242,526
Cost of pumping, figured on pumping station expenses,	\$12,577.03	\$111.53	\$13,947.57	\$29,135.78
Total pumpage for year, corrected for slip (million gallons),	1,016.02	10.02	2,824.12	9,368.71
Average dynamic head (feet),	133.48	116.65	120.36	121.70
Gallons pumped per pound of coal,	489.99	500.65	1,417.27	1,500.79
Duty on basis of plunger displacement,	56,170,000	50,880,000	144,960,000	155,230,000
Cost per million gallons raised to reservoir,	\$12.3787	\$11.1307	\$4.9387	\$3.1099
Cost per million foot gallons, . . . . .	.0927	.0954	.0410	.0256

	CHESTNUT HILL PUMPING STATION No. 2.	SPOT POND STATION.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	3,854,610	2,876,199
Cost of pumping, figured on pumping station expenses,	\$30,537.01	\$23,040.94
Total pumpage for year, corrected for slip (million gallons),	7,013.97	2,802.56
Average dynamic head (feet),	33.24	130.08
Gallons pumped per pound of coal,	1,819.63	974.40
Duty on basis of plunger displacement,	51,420,000	107,730,000
Cost per million gallons raised to reservoir,	\$4.3537	\$8.2214
Cost per million foot gallons, . . . . .	.1310	.0632

Consumption.

Estimated total population of the eighteen cities and towns supplied wholly or partially during the year 1917,	1,215,840
Total consumption (gallons), meter basis,	40,161,778,000 ¹
Average daily consumption (gallons), meter basis,	110,032,000
Gallons per day to each inhabitant, meter basis,	90.5

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	- ²	- ²
Sizes,	76-4 inch.	76-4 inch.
Extensions, less length abandoned (miles),	0.07	18.46
Length in use (miles),	122.34	1,901.29
Stop-gates added,	12	-
Stop-gates now in use,	533	-
Service pipes added,	-	2,803
Service pipes now in use,	-	182,192
Meters added,	-	4,622
Meters now in use,	-	131,630
Fire hydrants added,	-	236
Fire hydrants now in use,	-	17,543

¹ 58.79 per cent. pumped; 41.21 per cent. by gravity.² Cast-iron, cement-lined wrought-iron, cement-lined steel and kalamine pipe.

APPENDIX No. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

1.	2.	3.	AMOUNT OF BID.		6.	
			4.	5.		
Number of Contract.	WORK.	Number of Bids.	Next to Lowest.	Lowest.	Contractor.	
1	135 ¹	Section 1, Deer Island outfall extension, North Metropolitan System, Deer Island, Boston Harbor.	3	\$62,612 00	\$38,930 00 ²	Roy H. Beattie, Inc., Fall River.
2	140 ¹	6,900 tons of coal: — 2,700 tons for Deer Island pumping station. 3,000 tons for East Boston pumping station. 1,200 tons for Charlestown pumping station.	2 2 2	\$6.02 per ton. \$5.84 per ton. \$5.84 per ton.	\$5.90 per ton. ² \$5.65 per ton. ² \$5.75 per ton. ²	New England Coal and Coke Company, Boston.

¹ Contract completed.

APPENDIX No. 4.

THE YEAR 1917 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1917.	10. Value of Work done Dec. 31, 1917.	
April 22, 1916	Dec. 5, 1917	- - -	\$43,873 92	1
June 14, 1916	July 1, 1917	- - -	39,189 56	2

¹ Contract based upon this bid.

Contracts relating to the

1.	Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	133 ¹	Section 104, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	8	\$64,272 50	\$59,055 00 ¹	Bay State Dredging and Contracting Company, Boston.
2	136 ¹	Two vertical fire tube boilers for Ward Street pumping station.	2	12,300 00	9,160 00 ²	D. M. Dillon Steam Boiler Works, Fitchburg.
3	138	Section 98, High-level sewer, Wellesley extension, South Metropolitan System in West Roxbury and Dedham.	3	79,040 00	54,630 00 ¹	Thomas Russo & Co., Boston.
4	141 ¹	2,500 tons of coal for Ward Street pumping station.	1	-	\$5.63 per ton. ²	Staples Coal Company Boston.
5	143	Section 102, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	3	66,293 40	\$62,041 75 ²	Bruno & Petitti, Boston.

¹ Contract completed.

South Metropolitan System.

7. Date of Con- tract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1917.	10. Value of Work done Dec. 31, 1917.	
Dec. 22, 1915	Jan. 20, 1917	- - -	\$62,232 47	1
May 20, 1916	March 9, 1917	- - -	9,160 00	2
July 13, 1916	-	Work abandoned by the Contractor before any portion was completed. Work provided for is now being completed in accordance with the specifications by Geo. M. Bryne.	140,245 58	3
June 14, 1916	July 1, 1917	- - -	14,316 10	4
Oct. 2, 1916	-	- - -	66,081 29	5

* Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING THE YEAR 1917 — SEWERAGE WORKS
— *Concluded.*

Summary of Contracts.

	Value of Work done Dec. 31, 1917.
North Metropolitan System, 2 contracts,	\$83,063 48
South Metropolitan System, 5 contracts,	292,035 44
Total of 7 contracts made and pending during the year 1917,	\$375,098 92

APPENDIX No. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT
ON JANUARY 16, 1918.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1917, together with recommendations for legislation which it deems desirable, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1917, have been as follows:—

Loans authorized under Metropolitan Water acts,	\$42,798,000 00
Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320), . . .	90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund:—	
For the year ending November 30, 1917,	\$3,049 83
For the period prior to December 1, 1916,	250,597 81
	<hr/>
	343,647 64
	<hr/>
	\$43,141,647 64
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund:—	
For the year ending November 30, 1917,	\$68,938 11
For the period prior to December 1, 1916,	42,911,903 14
	<hr/>
	42,980,841 25
Balance December 1, 1917,	<hr/>
	\$160,806 39

The amount of the Metropolitan Water Loan bonds issued at the end of the fiscal year was \$42,752,000, bonds to the amount of \$150,000 having been issued during the year. Of the total amount

issued, \$41,398,000 were sinking fund bonds, and the remainder, amounting to \$1,354,000, were issued as serial bonds.

At the end of the year the amount of outstanding bonds was \$42,648,000, as bonds issued on the serial payment plan to the amount of \$104,000 had been paid. During the fiscal year \$32,000 in serial bonds has been paid.

The Metropolitan Water Loan Sinking Fund amounted on December 1, 1917, to \$14,036,278.88, an increase during the year of \$768,079.52.

Maintenance.

Amount appropriated for the maintenance and operation of works, for the year ending November 30, 1917,	\$572,900 00	
Special appropriation for protection of water supply in aqueducts (1911) remaining,	9,930 60	
Special appropriations for protection and improvement of the water supply (1912, 1913 and 1916) remaining,	21,455 13	
Receipts credited to this fund for the year ending November 30, 1917,	3,304 50	
	<hr/>	\$607,590 23
Amount approved by Board for maintenance and operation of works during the year ending November 30, 1917,	510,679 43	
	<hr/>	
Balance December 1, 1917,		\$96,910 80

This balance includes the sum of \$9,930.60, the amount remaining unexpended of the special appropriation for the protection of the water supply in aqueducts, and the sums of \$2,713.93, the amount remaining unexpended of the special appropriation in 1912, and \$56.89 of the special appropriation in 1913, and \$7,533.54 of the appropriation in 1916 for the protection and improvement of the water supply.

The Board has also received during the year ending November 30, 1917, \$74,023.22 from rentals, the sale of land, land products and power and from other proceeds from the operations of the Board, which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, in reduction of the amount to be assessed upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows:—

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	\$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1916, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	72,666 07
For the year beginning December 1, 1916, and ending November 30, 1917, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	4,134 35
	<hr/> \$296,666 07

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows:—

North Metropolitan System.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions, North System enlargements and extensions, New Mystic sewer, Deer Island Outfall extension, lowering sewer siphon under Malden River, balance of appropriation under chapter 76, Resolves of 1915, and for the Reading extension,	\$7,512,365 73
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:—	
For the year ending November 30, 1917,	127 57
For the period prior to December 1, 1916,	85,648 89
Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System:—	
For the year ending November 30, 1917,	\$37,829 87
For the period prior to December 1, 1916,	7,246,534 49
	<hr/> \$7,598,142 19
	<hr/> \$7,284,364 36
Balance December 1, 1917,	\$313,777 83

¹ The word "Board" refers to the Metropolitan Sewerage Commission and its successor, the Metropolitan Water and Sewerage Board.

South Metropolitan System.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions (including Wellesley Branch), and an additional appropriation authorized by chapter 285, General Acts of 1917, and for additional Ward Street station pumping plant, .			\$9,587,046	27
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:—				
For the year ending November 30, 1917, .			282	52
For the period prior to December 1, 1916, .			19,101	41
Amount approved by Board for payment as follows:—				
On account of the Charles River valley sewer,			\$800,046	27
On account of the Neponset valley sewer,			911,531	46
On account of the High-level sewer and extensions:—				
For the year ending November 30, 1917, .			248,784	36
For the period prior to December 1, 1916, .			7,384,405	67
			<hr/>	<hr/>
			\$9,606,430	20
			\$9,344,767	76
Balance December 1, 1917,			\$261,662	44

The amount of the Metropolitan Sewerage Loan bonds issued at the end of the fiscal year was \$16,761,412, bonds to the amount of \$325,000 having been issued during the year. Of the total amount issued, \$15,440,912 were sinking fund bonds, and the remainder, amounting to \$1,320,500, were serial bonds.

At the end of the year the amount of the outstanding bonds was \$16,665,412, as bonds issued on the serial payment plan to the amount of \$36,500 had been paid during the year, \$96,000 having been paid to December 1, 1917.

Of the total amount outstanding at the end of the year, \$7,413,500 was issued for the North Metropolitan System and \$9,251,912 for the South Metropolitan System. The Metropolitan Sewerage Loan Sinking Fund amounted on December 1, 1917, to \$3,925,792.75, of which \$2,475,165.88 was on account of the North Metropolitan System and \$1,450,626.87 was on account of the South Metropolitan System, an increase during the year of \$321,135.48.

The net debt on December 1, 1917, was \$12,739,619.25, a decrease of \$33,635.48.

Included in the above figures for the North Metropolitan System is \$925,500 in serial bonds, of which \$75,000 has been paid, and \$395,000 for the South Metropolitan System, of which \$21,000 has been paid.

Maintenance.

North Metropolitan System.

Appropriated for the year ending November 30, 1917,	\$210,666 66
Receipts from pumping and from other sources, which are returned to the appropriation: —	
For the year ending November 30, 1917,	262 97
	<hr/>
	\$210,929 63
Amount approved for payment by the Board: —	
For the year ending November 30, 1917,	187,408 58
	<hr/>
Balance December 1, 1917,	\$23,521 05

South Metropolitan System.

Appropriated for the year ending November 30, 1917,	\$135,666 67
Receipts from sales of property and for pumping, which are returned to the appropriation: —	
For the year ending November 30, 1917,	279 86
	<hr/>
	\$135,946 53
Amount approved for payment by the Board: —	
For the year ending November 30, 1917,	130,685 35
	<hr/>
Balance December 1, 1917,	\$5,261 18

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1917 AFFECTING THE
METROPOLITAN WATER AND SEWERAGE BOARD.

General Acts, 1917.

CHAPTER 3.

AN ACT TO AUTHORIZE THE CONSTRUCTION OF A TRUNK LINE
OF THE NORTH METROPOLITAN SEWERAGE DISTRICT
ACROSS A PART OF THE TOWN OF READING.*Be it enacted, etc., as follows:*1916 (G), 159, § 2,
amended.

SECTION 1. Section two of chapter one hundred and fifty-nine of the General Acts of the year nineteen hundred and sixteen is hereby amended by inserting before the word "Wakefield", in the fifth and sixth lines, the word: — Reading, — so as to read as follows: — *Section 2.* The metropolitan water and sewerage board shall provide an outlet at the Reading town line in or near Brook street for the sewage of said town, and, acting on behalf of the commonwealth shall construct a main trunk sewer or sewers through such parts of the towns of Reading, Wakefield and Stoneham and the city of Woburn from the Reading town line to such point in the north metropolitan system as said board may determine to be necessary in order to connect with a main trunk sewer in the Mystic valley.

North metro-
politan sewerage
district, trunk
line sewer may
be constructed
in Reading.

SECTION 2. This act shall take effect upon its passage.
[Approved February 8, 1917.]

CHAPTER 285.

AN ACT TO PROVIDE FOR COMPLETING THE EXTENSION
OF THE SOUTH METROPOLITAN SEWER TO THE TOWN OF
WELLESLEY.*Be it enacted, etc., as follows:*Commonwealth
to issue bonds
for completion
of the south
metropolitan
sewer to town
of Wellesley.

SECTION 1. The treasurer and receiver general, in order to provide for the completion of the extension of the high-level sewer authorized by chapter three hundred and forty-three of the acts of the year nineteen hundred and fourteen,

shall, with the approval of the governor and council, issue from time to time scrip or certificates of indebtedness in the name and behalf of the commonwealth and under its seal, to an amount not exceeding three hundred and twenty-five thousand dollars, in addition to the amount authorized by said chapter; and the provisions of said chapter and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine, and of all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness and proceedings authorized by this act.

SECTION 2. This act shall take effect upon its passage.
[Approved May 24, 1917.]

CHAPTER 287.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND
SEWERAGE BOARD TO CONSTRUCT A POWER TRANSMISSION
LINE BETWEEN THE WACHUSETT DAM AND THE SUDBURY
DAM.

Be it enacted, etc., as follows:

SECTION 1. To enable the metropolitan water and sewerage board to construct a line for the transmission of electricity between the power station at the Wachusett dam in Clinton and the power station at the Sudbury dam in Southborough, under authority of chapter one hundred and seventy-two of the General Acts of the year nineteen hundred and sixteen, the treasurer and receiver-general shall issue from time to time, upon the request of said board, bonds in the name and behalf of the commonwealth, designated on the face thereof, Metropolitan Water Loan, Act of 1917, to an amount not exceeding twelve thousand dollars, to be taken from the unexpended balance of forty-six thousand dollars authorized by chapter six hundred and ninety-four of the acts of the year nineteen hundred and twelve; and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and of acts in amendment thereof and in addition thereto, shall, so far as they may be applicable, apply to the indebtedness and proceedings authorized by this act.

Metropolitan
water and
sewerage board
to construct
power transmis-
sion line be-
tween Wachu-
sett and Sud-
bury dams.

Metropolitan
Water Loan, Act
of 1917.

SECTION 2. This act shall take effect upon its passage.
[Approved May 24, 1917.]

CHAPTER 314.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND
SEWERAGE BOARD TO SELL AND DELIVER WATER TO
CONCENTRATION CAMPS ESTABLISHED BY THE UNITED
STATES.

Be it enacted, etc., as follows:

Metropolitan
water and
sewerage board
may sell, etc.,
water to United
States concen-
tration camps.

SECTION 1. The metropolitan water and sewerage board is authorized to sell and deliver water from any of the reservoirs or aqueducts of the metropolitan water system to any concentration camp established in this commonwealth by the United States, and to lay and maintain such pipe lines and other works as may be necessary for the purpose, upon such terms and conditions as may be agreed upon by the duly authorized officer or representative of the United States government and said board.

Certain provi-
sions of law to
apply.

SECTION 2. The provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in amendment thereof shall apply to this act.

SECTION 3. This act shall take effect upon its passage.
[Approved May 25, 1917.]

CHAPTER 322.

AN ACT TO PROVIDE FOR THE CONSTRUCTION OF A WATER
MAIN IN THE EAST BOSTON DISTRICT OF THE CITY OF
BOSTON BY THE METROPOLITAN WATER AND SEWERAGE
BOARD.

Be it enacted, etc., as follows:

New water main
for East Boston.

SECTION 1. The metropolitan water and sewerage board is hereby authorized to construct a new thirty-six inch water main about eighteen hundred feet in length to provide an additional supply of water for the East Boston district of the city of Boston.

SECTION 2. To meet the expenses incurred under the provisions of this act, the treasurer and receiver general shall issue from time to time, upon the request of said board, bonds in the name and behalf of the commonwealth and under its seal, designated on the face thereof Metropolitan Water Loan, Act of 1917, to an amount not exceeding thirty thousand dollars, to be taken from the

Metropolitan
Water Loan, Act
of 1917.

unexpended balance of the amount authorized by chapter six hundred and ninety-four of the acts of the year nineteen hundred and twelve, and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and acts in amendment thereof and in addition thereto, shall, so far as are applicable, apply to the indebtedness and proceedings authorized by this act.

SECTION 3. This act shall take effect upon its passage.
[Approved May 25, 1917.]

Special Acts, 1917.

CHAPTER 150.

AN ACT RELATIVE TO THE WATER SUPPLY OF THE TOWN OF ASHLAND.

Be it enacted, etc., as follows:

SECTION 1. Section two of chapter four hundred and fifty-six of the acts of the year nineteen hundred and eight is hereby amended by striking out the semicolon after the word "corporation", in the seventh line, and inserting in place thereof the words: — or the whole or any part of its supply of water from any municipal corporation owning and operating water works, whose territory joins that of the town of Ashland, and any such municipal corporation is hereby authorized to furnish water for the town of Ashland upon terms mutually agreed upon, and from its own authorized sources of supply, — so as to read as follows: —

1908, 456, § 2,
amended.

Section 2. Said town, for the purposes aforesaid, may take, or acquire by purchase or otherwise, and hold the waters of any pond or stream or of any ground sources of supply, by means of driven, artesian or other wells within the limits of the town, and the water rights connected with any such water sources, or may purchase water from any individual or corporation or the whole or any part of its supply of water from any municipal corporation owning and operating water works, whose territory joins that of the town of Ashland, and any such municipal corporation is hereby authorized to furnish water for the town of Ashland upon terms mutually agreed upon, and from its own authorized sources of supply; and may avail itself of its existing rights and privileges reserved to it by

Town of Ash-
land may take
certain water
rights, etc.

the provisions of chapter one hundred and seventy-seven of the acts of the year eighteen hundred and seventy-two: *provided, however*, that nothing in this act shall be construed as increasing such rights and privileges, or may make arrangements for obtaining water from the metropolitan water system which shall be satisfactory to the town and to the metropolitan water and sewerage board, and may also take, or acquire by purchase or otherwise, and hold all lands, rights of way and easements necessary for collecting, storing, holding, purifying and preserving the purity of the water and for conveying the same to any part of said town; *provided*, that there is no infringement upon the existing rights and privileges of the metropolitan water system excepting as allowed for above, and *provided*, that no source of water supply and no lands necessary for preserving the quality of such water, shall be taken or used without first obtaining the advice and approval of the state board of health, and that the location of all dams, reservoirs and wells to be used as sources of water supply under this act shall be subject to the approval of said board. Said town may construct on the lands acquired and held under the provisions of this act, proper dams, reservoirs, standpipes, tanks, buildings, fixtures and other structures, and may make excavations, procure and operate machinery and provide such other means and appliances and do such other things as may be necessary for the establishment and maintenance of complete and effective water works; and for that purpose may construct wells and reservoirs, and establish pumping works, and may construct, lay and maintain aqueducts, conduits, pipes and other works under or over any land, water courses, railroads, railways and public or other ways, and along such ways in the town of Ashland, in such manner as not unnecessarily to obstruct the same; and for the purpose of constructing, laying, maintaining, operating and repairing such conduits, pipes and other works, and for all proper purposes of this act, said town may dig up or raise and embank any such lands, highways or other ways in such manner as to cause the least hindrance to public travel on such ways. Said town shall not enter upon, construct or lay any conduits, pipes or other works within the location of a railroad corporation, except at such time and in such manner as it may agree upon with such corporation, or, in

Proviso.

May take lands,
etc.

Proviso as to in-
fringement upon
rights of metro-
politan water
system.

May erect struc-
tures, lay pipes,
etc.

case of failure so to agree, as may be approved by the board of railroad commissioners.

SECTION 2. This act shall take effect upon its passage.
[Approved March 1, 1917.]

CHAPTER 269.

AN ACT RELATIVE TO THE INSTALLATION OF WATER METERS
IN THE CITY OF BOSTON.

Be it enacted, etc., as follows:

The provisions of section one of chapter five hundred and twenty-four of the acts of the year nineteen hundred and seven shall not apply to the city of Boston for the period of one year after the passage of this act, so far as such provisions relate to the equipment with water meters of five per cent of the water services in that city which were unmetered on the thirty-first day of December, nineteen hundred and seven. [Approved April 10, 1917.]

Installation of
water meters in
Boston.

CHAPTER 322.

AN ACT IN ADDITION TO THE SEVERAL ACTS MAKING APPROPRIATIONS FOR SUNDRY MISCELLANEOUS EXPENSES AUTHORIZED BY LAW.

Be it enacted, etc., as follows:

SECTION 1. The sums hereinafter mentioned are hereby appropriated, to be paid out of the treasury of the commonwealth from the ordinary revenue, unless otherwise specified, to wit:—

For the investigation by the metropolitan water and sewerage board of the condition and capacity of the present metropolitan sewer in the town of Arlington, as authorized by chapter twenty-two of the resolves of the present year, to be paid from the North Metropolitan Sewerage Maintenance Fund, a sum not exceeding one thousand dollars.

Investigation of
metropolitan
sewer in
Arlington.

SECTION 2. This act shall take effect upon its passage.
[Approved May 9, 1917.]

CHAPTER 346.

AN ACT TO CHANGE THE BASIS OF PAYMENTS IN LIEU OF TAXES ON REAL ESTATE HELD BY THE COMMONWEALTH IN THE TOWN OF STERLING FOR PURPOSES OF THE METROPOLITAN WATER SUPPLY.

Be it enacted, etc., as follows:

Basis of certain payments in lieu of taxes to the town of Sterling changed.

SECTION 1. Property held by the commonwealth in the town of Sterling for the purposes of the metropolitan water supply, if yielding no rent, shall not be liable to taxation therein, but the commonwealth shall annually in September pay to said town an amount equal to that which the town would receive for taxes upon the average of the assessed value of such land without buildings or other structures, for the three years last preceding the acquisition thereof, the valuation for each year being reduced by all abatements thereon; but any part of such land or buildings from which any revenue in the nature of rent is received shall be subject to taxation; and the provisions of sections eight, nine and ten of Part I of chapter four hundred and ninety of the acts of the year nineteen hundred and nine, and amendments thereof, shall apply to the reimbursement of said town by the commonwealth on account of said property.

Repeal.

SECTION 2. Section two of chapter four hundred and forty-five of the acts of the year eighteen hundred and ninety-seven is hereby repealed. [Approved May 23, 1917.]

CHAPTER 22.

RESOLVE TO PROVIDE FOR AN INVESTIGATION AS TO SEWAGE DISPOSAL IN THE TOWNS OF ARLINGTON AND LEXINGTON.

Investigation as to sewage disposal in the towns of Arlington and Lexington.

Resolved, That the metropolitan water and sewerage board shall investigate the condition and capacity of the present metropolitan sewer in the town of Arlington with especial reference to its capacity to receive and dispose of the sewage of that part of the town of Arlington tributary to the same, and of the town of Lexington. The said board is also authorized and directed to report a plan for the new sewer contemplated by section four of chapter five hundred and twenty of the acts of the year eighteen hundred and ninety-seven, in the valley of Mill or Sucker

Brook, so situated as to serve all parts of the said valley and such adjacent territory as, in the opinion of the board, should be served by the same. The board may employ such engineering or other assistance as may be necessary, and may incur an expense not exceeding one thousand dollars in carrying out the provisions of this resolve. The board shall report to the present general court not later than the first day of May, with plans and estimates of the cost of such construction as it may recommend. [*Approved March 8, 1917.*]

CHAPTER 114.

RESOLVE RELATIVE TO THE PAYMENT BY THE COMMON-WEALTH OF A SUM OF MONEY TO JACOB LANDER AND HARRIS LANDER.

Resolved, That the metropolitan water and sewerage board be authorized to investigate the claim of Jacob Lander and Harris Lander of Sherborn for damage to their property at Saxonville in the town of Framingham by reason of water escaping or released from a reservoir under the control of the metropolitan water and sewerage board, and to report to the next general court on or before the second Wednesday in January what compensation, if any, should justly be paid to them. [*Approved May 24, 1917.*]

Jacob Lander
and Harris
Lander.

INDEX TO LEGISLATION OF THE YEAR 1917 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

		Chap.	Sect.
A.			
APPROPRIATIONS.			
to provide for completing extension of South Metropolitan sewer to			
Wellesley,	G. 285	1	
to provide for construction of Wachusett-Sudbury transmission line, .	G. 287	1	
to provide for construction of water main in East Boston,	G. 322	2	
to provide for an investigation of Arlington sewer,	S. 322	1	
ARLINGTON.			
relative to investigation of sewage disposal in Arlington and			
Lexington,	Res. 22	—	
	S. 322	1	
ASHLAND.			
relative to water supply for,	S. 150	1	
B.			
BOSTON.			
relative to installation of water meters in,	S. 269	1	
E.			
EAST BOSTON.			
construction of water main in,	G. 322	1	
L.			
LANDER, JACOB AND HARRIS.			
relative to payment of money to,	Res. 114	—	
M.			
METROPOLITAN WATER AND SEWERAGE BOARD.			
authorized to construct water main in East Boston,	G. 322	1	
authorized to sell water to United States concentration camps,	G. 314	1	
R.			
READING.			
authorizing construction of trunk line sewer of North Metropolitan			
Sewerage District across part of town of,	G. 3	1	
S.			
STERLING.			
to make change in basis of payments in lieu of taxes,	S. 346	1	

U.

UNITED STATES CONCENTRATION CAMPS.

	Chap.	Sect.
authority to supply water to,	G. 314	1

W.

WACHUSETT-SUDBURY TRANSMISSION LINE.

to authorize construction of,	G. 287	1
---	--------	---

WATER METERS.

relative to installation of, in Boston,	S. 269	1
---	--------	---

WELLESLEY.

to provide for completing extension of South Metropolitan sewer to .	G. 285	1
--	--------	---

